Adapting to Climate Change

A report prepared under the Climate Change Act 2008

Dŵr Cymru
Welsh Water

Contents

EXECUTIVE SUMMARY 1

INTRODUCTION 5

1. FUNCTIONS IMPACTED BY CLIMATE CHANGE 5

2. APPROACH 11

3. SUMMARY OF RISKS WHICH AFFECT WELSH WATER'S FUNCTIONS 15

4. ACTIONS PROPOSED TO ADDRESS RISKS 18

5. UNCERTAINTIES AND ASSUMPTIONS 21

6. BARRIERS TO, AND INFLUENCES ON ADAPTATION, INCLUDING INTERDEPENDENCIES 22

7. MONITORING AND EVALUATION 24

REFERENCES 26

APPENDIX I
Risk register table

APPENDIX II
Impacts on water resource based on UKCP09 projections

APPENDIX III
PACT Summary Report Dŵr Cymru Welsh Water

APPENDIX IV
Brief description of existing 'process based' adaptation measures

Executive summary

This report has been voluntarily produced by Dŵr Cymru - Welsh Water in response to the Secretary of State's instruction to reporting authorities in England (including the water industry), under the Climate Change Act 2008. It has been produced in line with Defra's 'Adapting to Climate Change: helping key sectors to adapt to climate change' (2009), the statutory guidance to reporting authorities.

The executive summary provides information in accordance with the structure outlined in the statutory guidance to reporting authorities.

1. INFORMATION AND ORGANISATION

Welsh Water is a statutory water and sewerage undertaker supplying over 3 million people in Wales and some adjoining parts of England. We provide an essential public service to our customers by supplying their drinking water and then carrying away and dealing with wastewater. Section 1 in the main report describes our functions in more detail.

Our goal is to be recognised by our customers as being the best water company in the UK. Our strategic objectives (listed in full at Section 1.1) include, *"Responding to climate change - We will adapt our activities to deal with the potential consequences of climate change, while substantially mitigating our own 'carbon footprint' as an effective contribution to the wider effort within Wales".*

Rainfall is the raw material of our industry. The predicted changes to the climate have the potential to have a profound impact on all the services we provide. This has been confirmed by the risk assessments undertaken as part of this report.

2. BUSINESS PREPAREDNESS BEFORE THE DIRECTION TO REPORT WAS ISSUED

During the last decade Welsh Water has become increasingly aware of the threat posed by climate change.

Our strategic direction statement, 'Our Sustainable Future', which was published in November 2007 and looked ahead 25 years, acknowledged that climate change could have a major impact on our business, especially water resources and surface water management. The Statement therefore included a number of commitments (reproduced in the Introduction Section) designed to improve our ability to cope with climate change and to reduce our carbon footprint.

Our financial regulator, Ofwat, requires that investment by the water industry is undertaken in five yearly cycles. To accommodate this, the industry's plans for capital and operational expenditure are set out in five yearly 'asset management plans'. Welsh Water's current plan, which was finalised in November 2009 and covers 2010-2015, includes a number of projects and programmes designed, at least in part, to help our company to adapt to climate change. For example the plan includes measures to encourage alternative approaches to drainage, such as through the use of sustainable drainage systems.

Our Water Resource Management Plan, for the planning period 2010 – 2035, also reflects the need to adapt to climate change. Welsh Water is the first water company to incorporate UKCP09 projections into its water resource planning activities, which has enabled us to identify and seek to address the possible implications of the projections on our future water resources. These and other measures already in hand are described in more detail in Section 4.1.

3. IDENTIFYING RISKS DUE TO THE IMPACTS OF CLIMATE CHANGE

We used the preparation of this report as an opportunity for an internal consultation with relevant parts of our company plus some external experts to review and assess the potential risks that climate change poses to each part of our business over the next 25 years.

We initially prepared an outline of this report based on informal, one-to-one discussions with policy-leads. We then organised a one day climate change risk assessment workshop and invited a range of colleagues who could offer a variety of policy and operational expertise. Representatives from Halcrow Group, who are acknowledged experts in climate change, also attended the workshop. A total of 41 people from across different functions attended.

To structure some of the report and the discussions at the workshop we used the Water UK study, 'A Climate Change Adaptation Approach for Asset Management Planning' (2007) as it identifies a common approach for assessing adaptation risks in the UK water industry. The Water UK study highlights key climate variables for the water industry (drought, flood, sea level rise, and temperature rise) and identifies how they may impact water industry assets and operations in seven key asset based functions.

In addition to the asset based functions, potential climate change impacts on our non-asset based functions such as human resources and communication were also identified and discussed at the workshop.

Workshop participants were asked to use the matrix described in Section 2.2 of the attached report to assess the identified risks, with reference to the UKCP09 climate change projections and other acknowledged climate trend information.

The risks that were given a high score by the workshop were subsequently reviewed and moderated by a panel of policy leads, plus Halcrow representatives, to check that relevant factors had been taken into account and to ensure comparability of risk ratings.

We estimate that the production of the report has cost our company £35000 including staff time.

4. ASSESSING RISKS

The main measure we use to quantify any impacts on our business – including from climate change – is serviceability. This is defined by our financial regulator, Ofwat, as the capability of a system of assets to deliver a reference (i.e. expected) level of service to customers and to the environment now and into the future.

For the purposes of this report we employed a matrix to score the relative levels of risk. The matrix was based on the premise that the level of risk equates to likelihood multiplied by impact. Likelihood was rated on a scale of unlikely/fairly likely/very likely. The significance of potential impacts was characterised as either high, medium or low. Our matrix is described in detail in Section 2.2 of our report.

We consider that although the assessments undertaken for the purpose of this report are at broad strategic level, they will nonetheless be useful in identifying where further investigation of potential impacts and mitigation/adaptation measures may be warranted.

5. UNCERTAINTIES AND ASSUMPTIONS

Much remains uncertain about the extent and thus the impact of climate change. The science is very inexact and, hopefully, mitigation of green house gas emissions will have a significant positive effect. These uncertainties are reflected in UKCP09's probabilistic approach, which includes three different greenhouse gas emission scenarios. We – like the Welsh Assembly Government – have used the medium emission scenario, but this may not prove to be the most accurate.

The timing of impacts is also uncertain, making it difficult to know when we need to invest in further adaptation.

By incorporating an assessment of likelihood of a particular climate change impact into our risk assessment, we have endeavoured to factor levels of (un)certainty into our methodology. Although there is inevitably considerable subjectivity in our risk scoring processes, we do not consider that at this stage the greater effort required to identify risks and impacts with greater confidence is justified.

6. ADDRESSING CURRENT AND FUTURE RISKS DUE TO CLIMATE CHANGE – SUMMARY

We consider that, of the many predicted impacts and risks associated with climate change, there are three that could represent the greatest challenges for our business in the short or longer term.

The first of these is changing rainfall patterns. This could impact on the availability of the water we abstract for treatment as drinking water, on the capability of the aquatic environment to cope with our flows of treated wastewater and on the capacity of our sewerage to deal with the volumes of surface water. The impact of changing rainfall patterns is a recurrent theme that underpins much of this report.

The second is our interdependence on others outside our direct control. For example, water and wastewater treatment processes tend to be energy intensive, so our business relies on receiving continuous supplies from our energy provider. Information technology and transport links are also key. Interdependencies also have an influence on our adaptation measures and our ability to adapt.

The third, perhaps more uncertain issue, is demographic and social change. Climatic changes could lead to an increased migration into Wales. This could, in turn, eventually put a major strain on Wales' resources, including its water resources. Although this pressure is unlikely to be felt within the 25 year horizon covered by this report, we recognise that Welsh Water must remain mindful of this potential additional burden in the years ahead and so build it into our longer-term planning.

Our risk assessment suggests that many key priority impacts and risks for Welsh Water, predicted for the next 25 years, are being tackled by measures we already have in place. For example, we expect the high level of risks initially identified for water resource, water network and non-asset based functions to be reduced significantly by existing adaptation and mitigation measures. That said, we are not complacent and we recognise the need to keep these risks under review.

Our risk assessment also highlights areas where Welsh Water should give priority in developing new or additional adaptation measures. These are wastewater networks and wastewater treatment functions. Although there are some measures in place to reduce risks in these two functions, the number of impacts with high risk level is still significantly higher than other functions.

Table 1 (Section 3), lists high priority impacts for all Welsh Water's functions. These are impacts we have identified as at risk even after the existing measures are taken into account. These threats will be the subject of a more detailed scrutiny to see whether we should investigate taking additional adaptation actions. Proposed actions and time scales are not listed on Table 1 as further works on these will be undertaken as part of our business planning process.

We recognise that we are unlikely to be able to reduce some risks significantly as they are outside our direct control. This is where we have to rely on other stakeholders.

7. BARRIERS TO IMPLEMENTING ADAPTATION PROGRAMME

The barriers identified at Section 6 of this report include the potential costs of various adaptation measures: for example, some estimates suggest that it would cost Welsh Water around £500 million on increasing storage capacity as an adaptation action to address the potential impact on our wastewater network. To spend £500 million just on increasing storage capacity would compromise our ability to deliver to our customers the services they expect at an affordable price. We do not consider that providing ever increasing storage capacity is a sustainable approach in adapting to climate change (hence our drive to find sustainable alternatives to surface water management).

Our expenditure on any aspect of our business, including climate change adaptation, is effectively limited by our financial regulator, Ofwat, as it sets the limits on the prices we may charge.

If we are to ensure that our sewers do not become overloaded and cause localised flooding and environmental pollution, we need full control over them. However, the combination of current water and town and country planning legislation effectively gives much of the control to the local planning authority. Moreover, the UK and Welsh Governments have decided that private sewers should transfer to sewerage undertakers: these sewers are unlikely to have been constructed to the standards we would normally require and thus they pose a higher risk of causing flooding or pollution.

We are subject to a variety of obligations arising from, for example, European environmental Directives, which constrain our options as regards the location and level of treatment we give to our discharges. In addition, many watercourses in Wales are designated under the Habitats Directive in recognition of their conservation importance: this can, for example, limit the volumes of water we are allowed to take from these rivers. Stringent quality standards for drinking water are also prescribed in legislation. Our statutory regulators may need to adopt a more flexible attitude to some of these obligations if we are to overcome the challenges that climate change may bring in the future.

Discussions at our workshop highlighted our reliance on infrastructure outside our immediate control, which is also at risk of climate change impact. This includes our energy supply; transport links; information and communication technology. The delivery of some of our adaptation measures, particularly our efforts to improve surface water management, relies on local authorities playing their full part.

8. REPORT AND REVIEW

The water industry is required to produce asset management plans every five years describing our proposed capital and operational expenditure. In preparing our plans we must consider all threats to our serviceability during the period in question. Any proposed expenditure is subject to considerable scrutiny, including in terms of cost/benefit. Our financial regulator, Ofwat, sets our price limits for the relevant five years on the basis of these asset management plans.

Welsh Water is firmly of the view that climate change adaptation (and mitigation) must become embedded into this asset management planning process so that it will be evaluated alongside measures to tackle other potential threats to our serviceability. In this way, adapting to climate change will become 'business as usual'.

This approach will also help us to identify adaptation measures that will bring additional benefits, thus improving their cost effectiveness: for example, reducing the volumes of surface water entering our sewerage system will also reduce the likelihood of our sewers overflowing under current climatic conditions.

Another advantage of this approach is that it will ensure that our preparedness for climate change is reviewed in detail every five years. In that way, we will routinely review whether measures taken thus far are adequate or whether further action is needed.

Every year Ofwat closely examines our performance to check that we have provided the projects we have previously included in our asset management plans and that the investment has been completed on time. We are penalised if we fail to do so. For example, our current asset management plan includes surface water reduction schemes and flood resilience programmes: the delivery of these investments will be monitored and evaluated by Ofwat as part of this process.

Having said that, we acknowledge that the preparation of this report into climate change adaptation has been useful. We intend to keep this report under review so that, for example, any improvements in our understanding of the potential impact of climate change can be fed into our risk assessments.

In particular, we note that the Welsh Assembly Government's recent 'Climate Change Strategy for Wales' says "Before publication of the UK Climate Change Risk Assessment in 2012, we do not intend to require Reporting Authorities in Wales to prepare and submit adaptation reports." We will review this document when we receive a formal request from the Welsh Government to prepare an adaptation report.

9. RECOGNISING OPPORTUNITIES

Our risk assessment suggests that there may be an opportunity for Welsh Water to sell more of our water to those parts of the UK suffering from water stress. However, we recognise that this raises significant environmental and political sensitivities and it is not a policy we would develop without appropriate consultation with stakeholders, including with the Welsh Assembly Government and relevant regulators.

Our assessment confirms that the predicted wetter winters could mean an opportunity for greater water storage during winter and increased hydro-power production as winter water flow increases.

The increase in temperature may increase efficiencies in water, wastewater and sludge treatment processes.

Adapting to Climate Change

INTRODUCTION

This report has been voluntarily produced by Welsh Water in response to the Secretary of State's instruction to reporting authorities in England (including the water industry), under the Climate Change Act 2008. It has been produced in line with Defra's 'Adapting to Climate Change: helping key sectors to adapt to climate change' (2009), the statutory guidance to reporting authorities.

Welsh Water recognises that climate change poses a major threat to the water industry. We are committed to playing our part in mitigating and preparing for the impacts. We will seek to identify and embed suitable mitigation measures and adaptation actions in the business. As stated in our Strategic Direction Statement, published in 2007, in response to the changing climate by the year 2035 we will aim to achieve the following positions:-

- We will have implemented changes to our business activities to cope with extreme weather events, for example, through our highly developed Water Resource Management Plan and enhanced protection of our key assets.

- Through the delivery of our Surface Water Elimination and Reduction initiative, we will contribute fully to the implementation of Sustainable Urban Drainage (SUD) across our catchments with a view to reducing the volume of surface water entering the sewer system and overloading the network.

- We will have invested in low energy technologies, such as wind turbines and small hydrogenation units on our sites.

- We will have embedded a low carbon approach across all out activities and the reduction of carbon costs will be a major factor in our business planning and scheme development, particularly when considering increased treatment standards or assessing other carbon intensive investment schemes.

- We will have reduced our own carbon footprint by at least 50%.

We believe that as we work to maintain and improve our serviceability for our customers, risks from the changing climate along with other risks are and will continue to be taken into account in our business planning and decision making process.

To ensure consistency with the planning horizon of our Strategic Direction Statement and our Water Resource Management Plan, this report provides a high level risk assessment of the impact on our serviceability[1] that we expect as a result of climate change in the next 25 years.

This report highlights where impacts from climate change are already part of our business planning, what the priority risks are and what we plan to do in the future to ensure relevant climate change impacts are addressed effectively.

1. FUNCTIONS IMPACTED BY CLIMATE CHANGE

1.1. WELSH WATER'S FUNCTIONS, GOALS AND OBJECTIVES

Welsh Water is a statutory water and sewerage undertaker. We are owned, financed and managed by Glas Cymru, a single purpose company. Glas Cymru is a company limited by guarantee with no shareholders and any financial surpluses are retained or reinvested for the benefit of Welsh Water's customers.

Welsh Water is the sixth largest of the ten regulated water and sewerage companies in England and Wales. We provide an essential public service to more than three million people living in Wales and some adjoining parts of England.

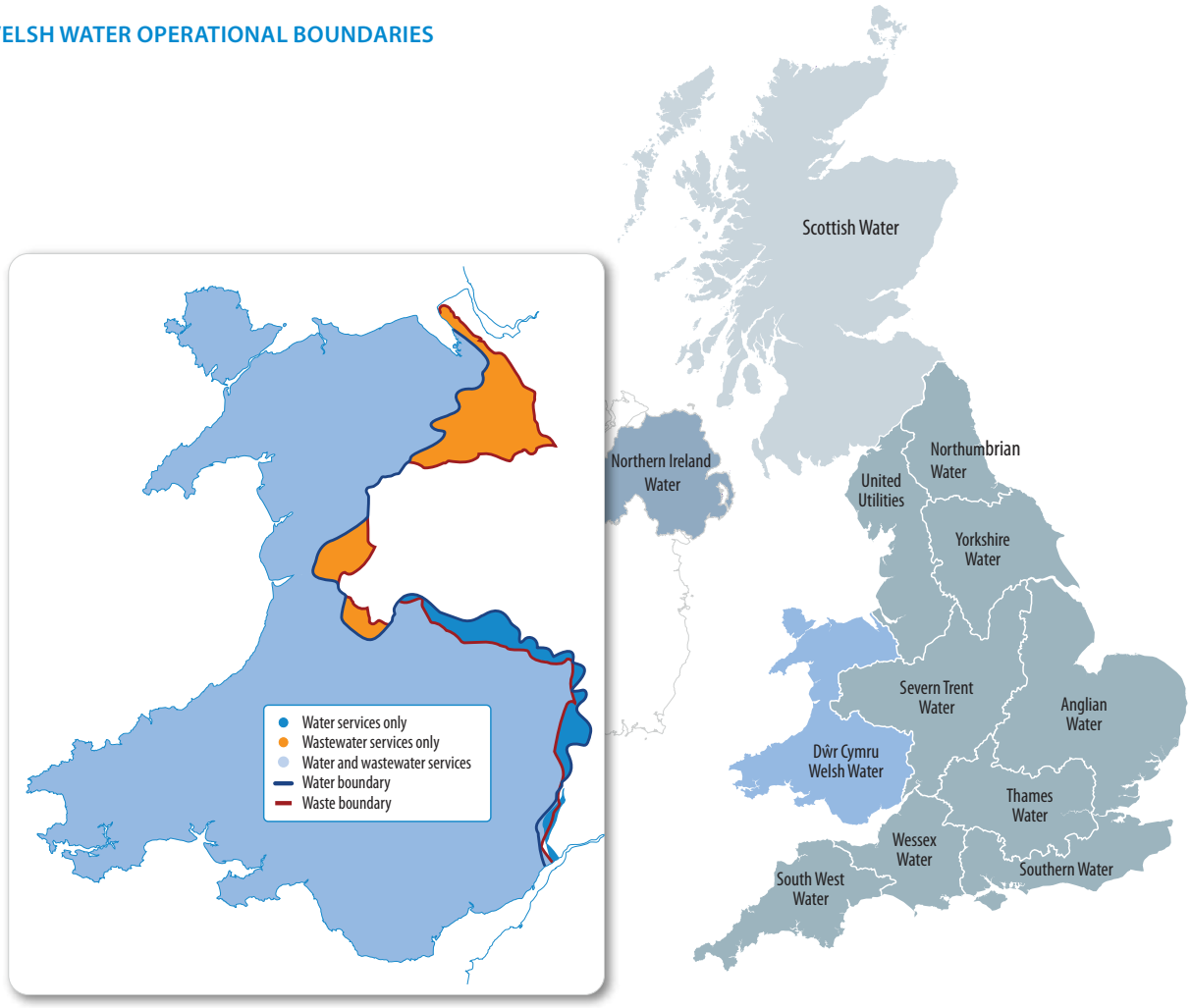
It is our responsibility to operate, maintain and upgrade efficiently our large network of assets so as to ensure a safe and reliable supply of drinking water for our customers and to then carry away and deal with wastewater so that both public health and the environment are protected.

The UK's water industry is capital intensive. Welsh Water employs a huge and complex network of often very long life assets – with a replacement cost of £25 billion, around £20,000 per household – to deliver water and sewerage services to our customers. We have 87 water treatment works and supply drinking water via 550 service reservoirs through a network of 27,000 km of main. We operate over 800 wastewater treatment works and in our 19,000 km sewer network we have about 1,800 pumping stations. The assets we own vary considerably in size and complexity: some of our assets serve only a few people while others serve hundreds of thousands of our customers.

Because we have long-life assets we want to be confident our assets will remain fit for purpose over many years to come when we plan future investment.

[1] *Serviceability is defined by Ofwat (2007) as the capability of a system of assets to deliver a reference (i.e. expected) level of service to customers and to the environment now and into the future..*

WELSH WATER OPERATIONAL BOUNDARIES



The geography of our operational area presents us with special challenges in terms of climate change mitigation and adaptation. Our region is the third largest amongst the water and sewerage companies in England and Wales, but we are only the sixth largest in terms of numbers of customers. As a result of the comparative scarcity of the population in our region, we employ relatively more water supply assets per customer than other companies, and those assets are, on average, commensurately smaller: for example, we operate some 10% of the industry's water mains and some 13% of the wastewater treatment works. The scarcity of our customer base means we have to pump water long distances, which adds further to our energy use.

Our operating area is also characterised by a relatively long coastline, boasting many high quality bathing waters. A significant proportion of Wales' major rivers (including the Rivers Dee, Usk and Wye amongst others) are designated in recognition of their conservation importance. We therefore operate a large number of treatment works providing advanced levels of treatment, which inevitably increases our energy demand.

Having said that, our operating area is also characterised by average rainfall which is amongst the UK's highest and so, when compared with other companies, our water resources position is generally satisfactory.

Our goal is to be recognised by our customers as being the best water company in the UK. To achieve our goal, we set out eight strategic objectives as follows;

PROTECTING PUBLIC HEALTH
Customers can have complete confidence in the safety of their drinking water.

SAFEGUARDING THE ENVIRONMENT
In providing services for our customers, we will protect the environment within which we all live, taking a holistic view of environmental impact at a local, river basin and global level.

RESPONDING TO CLIMATE CHANGE
We will adapt our activities to deal with the potential consequences of climate change, while substantially mitigating our own 'carbon footprint' as an effective contribution to the wider effort within Wales.

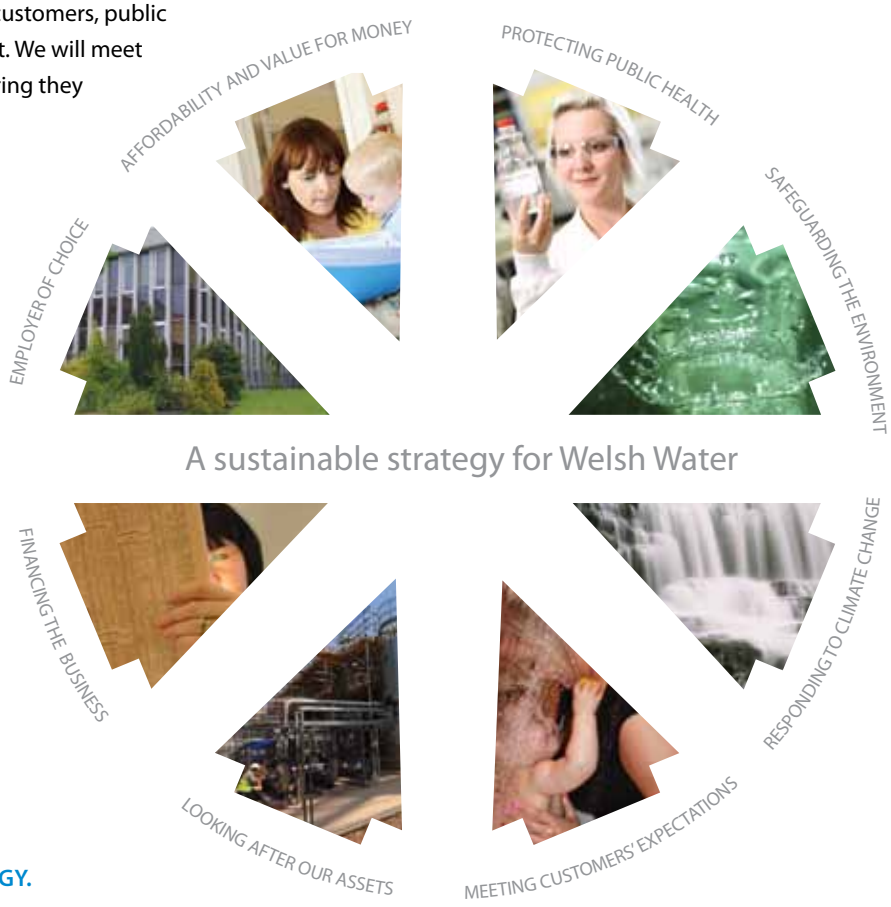
MEETING CUSTOMERS' EXPECTATIONS
We provide services that are essential to customers, public health and the quality of the environment. We will meet customers' increasing expectations, ensuring they have complete confidence in our service.

LOOKING AFTER OUR ASSETS
Our long-term asset planning will ensure the continuation of enhanced standards for the benefit of future generations, at the lowest 'whole life' asset cost.

FINANCING THE BUSINESS
We will minimise the burden of financing costs on our customers for years to come by offering a high credit quality to long-term investors.

EMPLOYER OF CHOICE
The best people will be proud to work for us because of the quality of service the company provides, the opportunities we offer and the safe environment within which we work.

AFFORDABILITY AND VALUE FOR MONEY
Our customers will regard the services we provide as affordable and good value for money, with a range of help targeting customers who struggle to pay.



WELSH WATER'S SUSTAINABLE STRATEGY.

1.2. FUNCTIONS AFFECTED BY THE CURRENT AND POSSIBLE FUTURE IMPACTS OF CLIMATE CHANGE

Climate change can potentially have a very significant impact on most of our functions.

Changing rainfall patterns are already causing the quality of some of the water we abstract to deteriorate. Looking ahead, a warmer, drier summer climate will reduce the flows in the rivers from which we abstract and it is likely to increase demand for water. Alternative sources may need to be found which may be more expensive, in financial and/or environmental terms.

The 2007 flooding in England showed the vulnerability of water infrastructure to extreme weather events; when the loss of Mythe Water Treatment Works near Gloucestershire left 350,000 people without drinking water. Welsh Water is already working with the Environment Agency to understand where its key assets most at risk of being flooded are located.

The predicted more frequent intense rainfall will put increased strain on our sewerage systems, thus potentially leading to more local flooding. It would be impractical, as well as prohibitively expensive, to build ever larger sewers to cope with the increased flows we are likely to experience in the future. Welsh Water is therefore at the forefront of trying to find alternative approaches to drainage, such as removing surface water from sewerage systems through the use of sustainable drainage.

We rely on our skilled workforce to deliver our services to our customers. The changing climate may increase the number and duration of staff absences. It may also hamper the day-to-day operation of our staff, for example localised flooding may prevent staff from being able to reach their workplace. New health and safety issues may need to be overcome.

In Section 3 we provide a summary of functions identified as being at risk from climate change even after our existing and planned adaptation measures have been taken into account.

Apart from the potential impact on our own assets, Welsh Water's serviceability could be jeopardised if climate change affects our suppliers or the infrastructure we depend on.

For example:-

- Certain chemicals are used as part of the treatment process to ensure that our drinking water complies with various statutory standards to protect public health. We normally stockpile quantities of these chemicals to minimise disruption to our processes. However, this may not be sufficient in the event of a prolonged disruption caused by severe weather such as major flooding. This could impact on our serviceability and thus public health.

- Energy is essential for our operation. Although we are trying to identify and develop alternative and renewable energy sources, we still rely heavily on the continuous supply from our energy provider. Despite our own in-house plans to cope with flooding, we may not be able to maintain our service to the customers if our energy provider is unable to supply energy because of flooding.

- We also depend on transport infrastructure and Information and Communication Technology (ICT) in operating our assets and delivery our services.

Our interdependencies with other infrastructure are highlighted in Section 6.2.

1.3. CLIMATE CHANGE THRESHOLDS

Rainfall is the raw material of our industry and all projections of the impacts of climate change in Wales predict major changes in rainfall patterns. We must adapt if we are to continue to be able to deliver our services reliably and without damaging the aquatic environment. Indeed, as noted above, Welsh Water is already experiencing the effects of climate change in some areas.

However, our assets and functions are complex and cover a large area (see Section 1.1), making it impractical to determine climate thresholds above which climate change and weather events will begin to pose a threat to individual assets within our organisation. Thus we can see no point in trying to identify climate change thresholds per se.

Having said that, there are thresholds that are relevant to our business and which can also serve this purpose. These criteria and standards focus on maintaining the level of services expected by our customers while also protecting the environment. These include the serviceability indicators determined by our economic regulator, Ofwat. For our water resource function, deployable output and supply-demand balance are effectively our service thresholds.

The advantage of this approach is that it recognises that climate change is only one of many risks relevant to our organisation. We believe that by focussing on maintaining our serviceability, the risks of climate change will have to be addressed as part of our asset management processes, so encouraging climate change adaptation to become well embedded within our company's routine planning mechanisms.

1.4. KEY STAKEHOLDERS AND REGULATORS

Our key stakeholders are our customers, the three million people and over 100,000 business customers who rely on the continued availability of the essential services we provide.

In the absence of shareholders, Glas Cymru (our parent company) has some 70 members drawn from our customer base who ensure that our business remains focused on its primary purpose of providing high quality water and sewerage services to the communities served by Welsh Water.

We put considerable effort into establishing the views of our customers before we finalise our five yearly investment programmes, and our current business plan for 2010-2015 had a high level of customer acceptability.

It is also a high priority for us to ensure that our customers are able to afford their water bills – especially those on low incomes. The need to keep our bills affordable impacts on our ability to invest in climate change measures.

We appreciate that our business customers also depend on the services our company provides. Any major and widespread disruption to our services would damage the Welsh economy. The Welsh Assembly Government's revised economic policy, set out in 'Economic Renewal: A New Direction' (2010) rightly emphasises the importance of adequate infrastructure to enable economic growth and Welsh Water recognises our role in the delivery of this policy.

Our workforce is essential to the success of our business. We appreciate that they too have a stake in the success of the company.

As part of the water industry in England and Wales, we are heavily regulated by a number of statutory bodies. All aspects of our operations are subject to extensive performance monitoring against standards and targets set by our regulators and government. Our regulators publish annual reports that assess and compare the performance of the regulated water companies across a wide range of measures, including water quality, environmental quality, customer service, affordability and cost efficiency. Each has powers that can sanction Welsh Water in the event that performance falls short of required standards.

The ***Water Services Regulation Authority (Ofwat)*** is the economic regulator and promotes the interests of customers by incentivising efficiency and high standards of service and penalising inefficiency and poor service.

Every five years Welsh Water, like all the other water companies, prepares plans – 'asset management plans' - setting out what needs to be done, what it will cost and what it means for customers bills. Projects included in these plans have to be subject to cost/benefit and risk analyses. Ofwat scrutinises and challenges these plans and then sets a maximum price that each water and sewerage company can charge to deliver an agreed amount of work as efficiently as possible. In December 2009, Ofwat published its final determination for Welsh Water for the regulatory cycle from 2010 to 2015, known as the 5th Asset Management Plan (AMP5).

Particularly through its price setting role, Ofwat can heavily influence our investment plans, including programmes designed to prepare Welsh Water for the impacts of climate change. For example, Ofwat was initially cautious about allowing funding in AMP5 for our proposals to improve surface water management: as we regard this as a key part of our plans to improve our preparedness for climate change we were very pleased that Ofwat did eventually support this investment.

The ***Drinking Water Inspectorate*** monitors drinking water quality. The ***Environment Agency*** regulates Welsh Water's environmental performance, specifically with regard to the way in which we abstract water from rivers and reservoirs and then discharge wastewater after it has been cleaned. Both regulators have a role in ensuring that we meet national and European quality standards. They also look at our five yearly Asset Management Plans, including those elements designed to overcome the impact of climate change, and submit their views to Ofwat. Looking ahead, these regulators may need to be more flexible in their regulatory approach to enable the water industry to continue to function in some of the extreme weather conditions predicted.

The ***Countryside Council for Wales*** and, in England, ***Natural England*** oversee Welsh Water's management of designated sites for nature conservation and how the company meets its obligation to conserve and improve biodiversity. Many of the main rivers and estuaries in Wales are designated for their conservation importance, and the Countryside Council for Wales is keen that our activities do not compromise the ability of protected species to cope with climate change.

The Consumer Council for Water is the independent body established to represent the interests of customers. It investigates complaints, addresses particular customer concerns and audits Welsh Water's performance on customer service more generally as well as influencing policy.

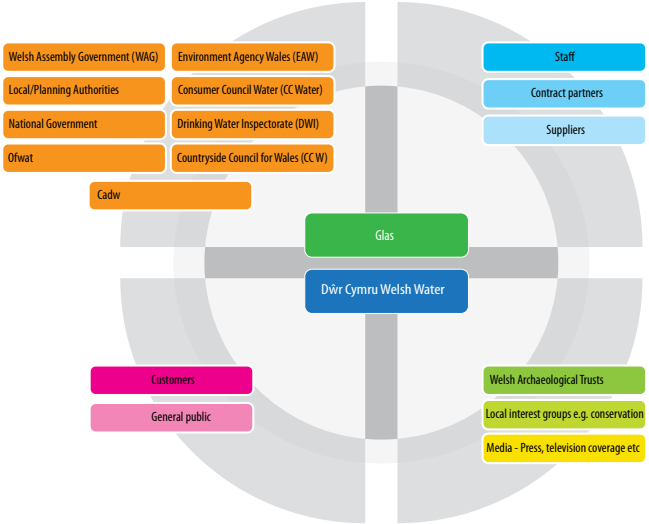
The ***Welsh Assembly Government*** has a key role in shaping water and environmental policy as well as setting the framework for other public policy matters in Wales, including sustainable development and climate change. Its Climate Change Strategy for Wales was published in early October 2010 and sets out how the Welsh Assembly Government will deliver its 'One Wales' commitments, including its targets for emission reduction, and set priorities for adaptation to the impact of climate change. Welsh Water has been supporting the Assembly Government in the development of its climate change strategy and will continue to take account of and help to deliver the national policies set out for Wales by the Assembly Government.

In addition to the regulators mentioned above, there are other key stakeholders that can influence our business and operation. These include our contractors and suppliers, local authorities, conservation bodies and media. The diagram below highlights our regulators and key stakeholders.

As part of our day-to-day business practice including business planning, we maintain an open and regular communication with our stakeholders. We believe we have good working relationships with all our key regulators and we seek to work in partnership with them to deliver benefits for our customers and the environment we operate in.

For the purpose of this report and the risk assessment, we engaged with our stakeholders where possible. Internally, we involved in-house expertise across the business in the risk assessment process and identifying adaptation actions. Externally, we shared and discussed our risk assessment approach with other companies in the water industry (this is through our trade association - Water UK) to identify issues and solutions that can be generically applied to the whole industry. We engaged with Defra and Ofwat (through the Water UK) and the Welsh Assembly Government. Particularly with the Welsh Assembly Government, we openly shared with them our information and approach to identifying climate change adaptation actions. We also took part and proactively contributed to the UK and Wales Climate Change Risk Assessment (CCRA[2]) project.

WELSH WATER'S KEY STAKEHOLDERS AND REGULATORS



[2] *CCRA first stage produced eleven sectors reports. Water sector was included, however, this only focuses on resources, demand and quality of water supply.*

2. APPROACH

2.1. EVIDENCE OF CLIMATE CHANGE IMPACTS IN WALES

The National Assembly for Wales initiated a study on the impact of climate change in Wales. The study, published in 2000, covers predictions up to year 2080. The study is based on the UK Climate Impact Programme 1998 (UKCIP98). The highlight from the study is that by year 2080 Wales will experience: -

- greater warmth all year round by 1.1-2.9 oC
- more precipitation in winter by 7-24 %
- less precipitation in summer by 7-14 %
- greater annual precipitation by 2-9 %
- a rise of sea level of 18-79 cm
- a higher mean windspeed by 1-4 %
- more evapotranspiration by 13-27 %
- more variability from year to year and the number of extreme years will increase
- more frequent and more rain in intense storms
- more drought years by 10 %
- more very severe gales by 10 %

The above findings were a basis for the Welsh Assembly Government to form its view on climate change impacts in Wales.

The latest UK climate projections were published in 2009 (UKCP09). The projections give climate information for the UK up to the end of this century, in relation to 1961 – 1990 baseline data. UKCP09 shows three different scenarios representing high, medium and low greenhouse gas emission scenarios, to highlight the importance of reducing emissions (mitigation).

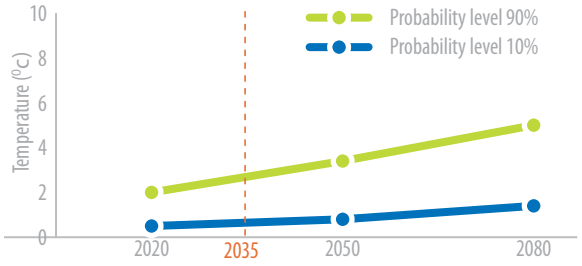
Key findings from the UKCP09 for Wales are the same as those for the rest of the UK: -

- Warmer and wetter winters
- Warmer and drier summers
- Sea level rise
- Increase in frequency and/or intensity of extreme weather events

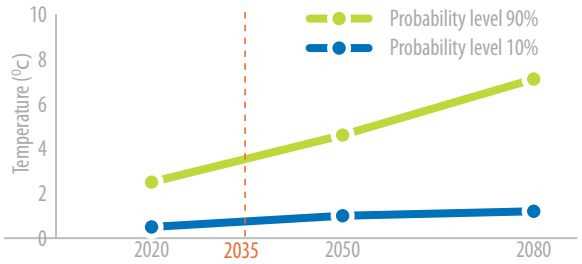
The following graphs show the UKCP 09 projections for Wales, using 'wider range'[3] values to illustrate the maximum and minimum projected values for mean temperatures and precipitation. Central estimates for all three emission scenarios are used to illustrate changes in sea level.

GRAPHS ILLUSTRATING CLIMATE PROJECTIONS FOR WALES (BASED ON UKCP09)

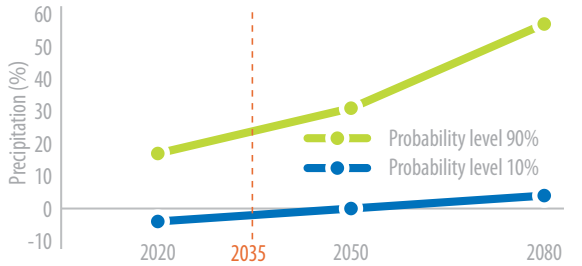
WIDER RANGE ESTIMATES- CHANGE IN MEAN WINTER TEMPERATURE (°C)



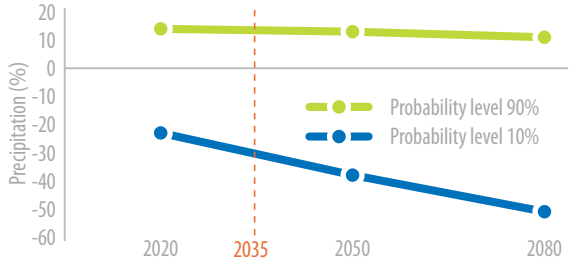
WIDER RANGE ESTIMATES- CHANGE IN MEAN SUMMER TEMPERATURE (°C)



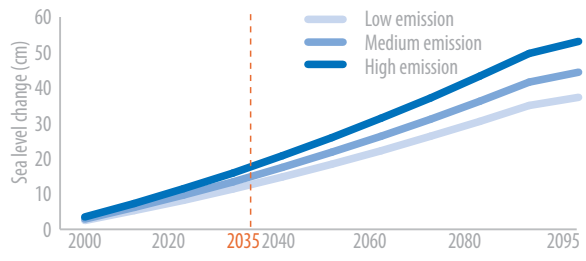
WIDER RANGE ESTIMATES- CHANGE IN MEAN WINTER PRECIPITATION (%)



WIDER RANGE ESTIMATES- CHANGE IN MEAN SUMMER PRECIPITATION (%)



SEE LEVEL CHANGE - (UKCP09 CENTRAL ESTIMATES)



[3] *The wider range is defined as the range from the lowest to highest value for all three greenhouse gas emissions scenarios (high, medium and low) and all three (10, 50, and 90%) probability levels for each 30-year time period.*

Ofwat published a report prepared by the Met Office (July 2010), which forecasts how the frequency of extreme rainfall events may change across England and Wales over the next 80 years. Six towns and cities within our operation area were included in the study. The report outlines a potential scenario to which the water industry sector needs to be ready to respond, including extreme rainfall events becoming more frequent in winter, with the biggest change projected to occur between the present day and the 2040s. Changes in summer are, however, much less clear.

Based on this report, Ofwat has recommended that the design standards and philosophies for sewers and drainage systems need to be adapted to cope with this potential future scenario.

2.2. QUANTIFYING THE IMPACT AND LIKELIHOOD OF RISKS OCCURRING IN THE FUTURE

To ensure consistency with our strategic direction statement and our Water Resource Management Plan, the risk assessment in this report covers potential impacts on our service in the next 25 years (up to year 2035).

The risk assessment for this report was undertaken based on a Water UK study, A Climate Change Adaptation Approach for Asset Management Planning (2007)[4]. The study identified, for the water industry, a common approach for assessing adaptation risks, and their incorporation into asset management planning. It also proposed a set of generic strategic adaptation response options for the industry.

Key climate variables for the water industry are highlighted in the study. These are drought, flood, sea level rise, and temperature rise. The Water UK study then identified how changes in these variables may impact water industry assets and operations in seven key asset based functions: -

- Water resources
- Water treatment
- Water networks
- Wastewater networks
- Wastewater treatment
- Sludge management
- Site wide services

Our risk assessment did not focus on 'site wide services' as we feel that the potential impacts identified by the Water UK study for this function are also covered in the other six asset based functions. In addition to the six asset based functions, we also undertook risk assessment for non-asset based functions (which also cover some aspects of 'site wide services' function). The non-asset based functions include human resources, information and communication, health and safety of staff, supply-chain management and business continuity management.

Focusing on maintaining our serviceability, the risk assessment in this report considers the level of 'impact on service' in combination with the likelihood that the impact will occur in the next 25 years.

Appendix I contains risk register tables for the six asset based functions and the non-asset based functions. For each function, 'primary impacts' of the four key climate variables are identified. Then, 'Impacts on service' that can be expected to result from each of the identified 'primary impacts' are listed for risk assessment.

In-house expertise (including that within our contract partners) was utilised in the quantification and estimation of risks. Engagement with in-house experts in each business function was undertaken in a climate change risk assessment workshop and discussions. Assistance from external experts was sought to ensure constructive discussions and critical review of our assessment.

For the purpose of this report, UKCP 09 projections for the medium greenhouse gas emission scenario and the wider range of uncertainty values were used as a reference for estimating risks. Medium scenario projections were also used for our Water Resource Management Plan.

Results from Ofwat's report on changes in the frequency of extreme rainfall events (Met Office, 2010) were also used for discussion to estimate risks and identify adaptive options.

In assessing our risks, we also took into account the on-going UK CCRA, particularly the report on the Water Resource Sector. However, this does not take precedence over the findings

[4] 'A climate change adaptation approach for asset management planning' (2007) provided water companies with a consistent set of climate change adaptation information for asset management planning, particularly for the last review undertaken in 2009 by Ofwat of company water price limits the price review. It also provided information on climate change impacts and adaptation options that can be fed into water companies' 25-year water resource plans, strategic direction statements and business plans where appropriate.

from our own revised Water Resource Management Plan, which comprehensively incorporated the latest climate projections and took account of the local characteristics of our operating environment.

RISK ESTIMATION

A three by three risk assessment matrix was used to quantify the level of risk of an 'impact on service' listed on the risk register tables (Appendix I). In order to narrow the scale of subjectivity in the scoring process, three likelihood levels and three impact levels are defined as follow: -

Likelihood – Question to ask for each of 'the impacts on service' listed on the risk registration tables: -
Taking into account the current capacity of the asset, climate trends and the extreme weather events we recently experienced, how likely is it that 'the impact on service' will happen within the next 25 years as a result of 'the primary impact' of climate change?

1 – It is unlikely the impact on service will occur in the next 25 years.
2 – It is fairly likely the impact on service will occur in the next 25 years. This should be where there is already some evidence from trends and historical data.
3 – It is very likely the impact on service will occur within the next 25 years. This is particularly where there is evidence of this happening.

Impact – Question to ask for each of the 'impacts on service' listed on the risk registration tables: -
What can the level of the 'impact on service' be referred to as?

1 – Low impact refers to a scenario where the impact does not involve loss of service and the asset can continue its function.
2 – Medium impact refers to a scenario where minor loss of service to customers is expected.
3 – High impact refers to a major loss of service to customers or a complete service failure.

Risk estimation was carried out in two stages. Firstly, the risk value of the impact was estimated under the current asset conditions without taking into account existing or planned measures that provide climate change adaptation and mitigation. The estimated risk value, therefore, represents a level of impact on the business function in the absence of any adaptation and mitigation measures.

In the second stage, the risk estimation considered all of Welsh Water's existing and planned adaptation and mitigation measures to identify the level of 'residual risk' associated with the impact. Thus these residual risk values highlight areas where new or additional measures are required to further reduce the risk values to an acceptable level.

This two-stage risk estimation process allows us to see the benefits of adaptation and mitigation measures in a simple way by using the difference between risk of impact 'without' and 'with' adaptation and mitigation measures. It also provides a great degree of flexibility for the risk estimation to be revisited when more information and evidence become available in the future as we progress further on understanding and adapting to a changing climate.

Risk estimation results are as shown in the risk register tables in Appendix I to this report.

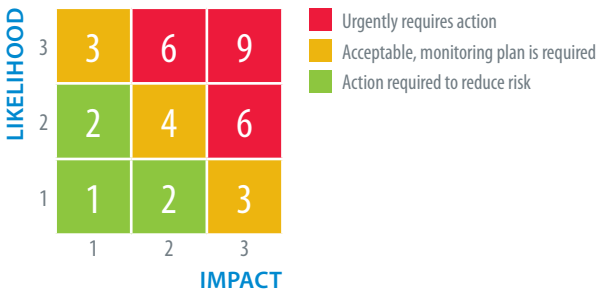
RISK VALUES

Risk = likelihood x impact
Estimated residual risk values were used for prioritising where Welsh Water needs to give attention to identifying appropriate adaptive actions in response to the impacts.

Potential impacts with residual risk values of 6 or 9 are considered as high priority impacts, urgently requiring actions to reduce the level of risk.

For impacts with estimated residual risk values of 3 or 4, actions to further reduce the level of risks are required, but have medium priority.

Where residual risk value is estimated at 1 or 2, the level of the impact is considered to be acceptable. However, measures in the form of a monitoring plan or a review is required to ensure the risk level continues to be acceptable and does not change.



We believe that the approach we undertook to assess climate change risks for our organisation mirrors 'The Risk, Uncertainty and Decision-Making Framework' recommended by the UK Climate Impact Programme (Willows & Connell, 2003) – Diagram below. In particular, Stages 3, 4 and 5 of the framework are reflected in our climate change risk assessment process described in this report. This approach also resembles our existing business planning processes, so in other words, it is 'business as usual' for us.

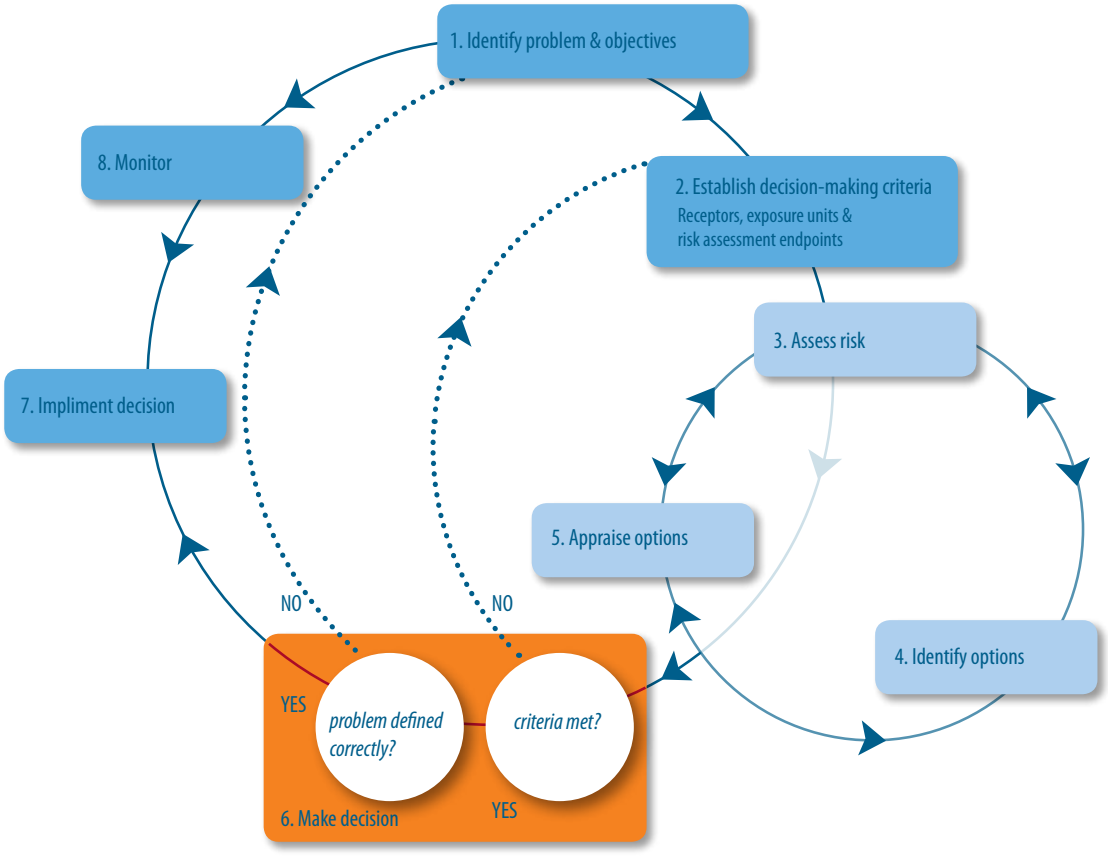
2.3 COSTS AND BENEFITS ANALYSES

The industry's five yearly asset management planning process already incorporates cost-benefit analysis (as well as risk assessment and costing exercises) to justify our investment programme. Therefore cost-benefit analysis will have been undertaken for adaptation actions that have already been completed or are included in our current asset management plan for the five years 2010 to 2015.

For any additional adaptation options emerging from this report, further scrutiny will be required prior to progressing with cost-benefit analysis of the measures.

This will be done in preparation for and as part of the next asset management planning process for the five years 2015-2020. The advantage of this approach is that it ensures that proposed adaptation options will not be considered and analysed in isolation - instead, they will be an integral part of our business planning processes, climate change being one of many risks to our business that we have to take into account.

UKCIP'S RISK, UNCERTAINTY AND DECISION-MAKING FRAMEWORK (WILLOWS & CONNELL, 2003)



3. SUMMARY OF RISKS WHICH AFFECT WELSH WATER'S FUNCTIONS

3.1 STRATEGIC RISKS AND IMPACTS

We consider that, of the many predicted impacts and risks associated with climate change, there are three that could represent the greatest challenges for our business in the short or longer term.

The first of these is changing rainfall patterns. This could impact on the availability of the water we abstract for treatment as drinking water, on the capability of the aquatic environment to cope with our flows of treated wastewater (because drier summers will reduce the available dilution) and on the capacity of our sewerage to cope with volumes of surface water (because of wetter winters and more stormy weather).

The second is our interdependence on services outside our direct control. The results from our risk assessment also confirm the significance of this issue. For instance, through our in-house risk assessment workshop and discussions, we have identified some risks that may remain high even when Welsh Water puts all necessary measures in place. This is where we have to rely on other stakeholders, particularly those supplying power and transport infrastructure. These interdependencies are further discussed in Section 6.2.

The third, perhaps more uncertain issue, is demographic and social change. During the preparation of this report, possible demographic shifts cause by climatic changes were identified as having a potential impact on Welsh Water. For example, a changing climate could lead to an increased migration into Wales from elsewhere in the UK (e.g. in response to rising sea levels inundating parts of the coastline) or from further afield (e.g. in response to intolerably high temperatures). This could, in turn, eventually put a major strain on all of Wales' resources and infrastructure. Given that temperature rises will, themselves, increase the demand for water, such demographic change may have a disproportionately high impact on Wales' water resources. Although this pressure is unlikely to be felt within the next 25 years, so is outside the timeframe of this report, we nevertheless considered it and concluded that Welsh Water must build these factors into our longer-term plans.

In addition to the above, resulting from the risk estimation and evaluation process described in Section 2, high priority impacts (those with a residual risk value of 6 or 9) for each of the asset based functions and the non-asset based functions are summarised in Table 1. In comparison to impacts with lower risk levels, these are risks for which new or additional measures may be urgently required to reduce the level of risk, subject to further scrutiny (e.g. cost/benefit).

3.2 HIGH PRIORITY CLIMATE CHANGE IMPACTS

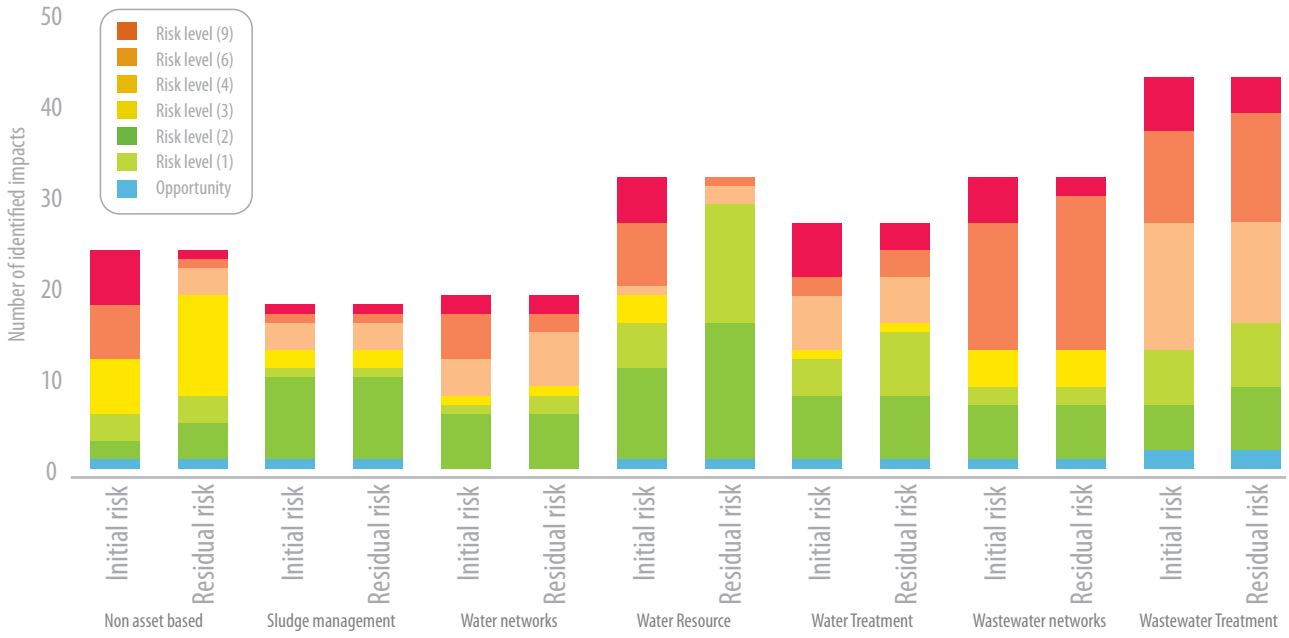
The availability of adequate water resources is vital if we are to maintain our level of serviceability in terms of drinking water.[5] It is therefore in this area of the business that much of our effort to adapt to climate change has hitherto been focused. The incorporation of UKCP09 climate projections into our Water Resource Management Plan has enabled us to identify possible impacts and Welsh Water has already completed or has plans in place to undertake work to reduce identified risks to acceptable levels. Our recent risk assessments confirmed that without the adaptation measures we have in hand, the level of risk of impacts on the company's water resource function could be unacceptably high.

We have also put considerable effort into identifying clean water assets including water treatment works that may be vulnerable to flooding.

Our other major priority is in trying to divert surface water away from our foul sewers to avoid them becoming overloaded by the more frequent and intense storms we expect.

The diagram below illustrates that there are measures already in place to tackle many key priority impacts and risks for Welsh Water, including the areas mentioned above. For example, the high level of risks initially identified for water resource, water network and non-asset based functions are considered to be significantly reduced by existing measures. The diagram also indicates that in some functions, such as wastewater network, the existing measures do not have enough influence to reduce a high priority status from some of the impacts.

RISK REDUCTION CONTRIBUTED BY WELSH WATER'S EXISTING MEASURES.



[5]The impacts on Welsh Water's available water resources (Deployable Output – DO) and Supply Demand Balance are summarised in Appendix II. The assessment was based on the UKCP09 predictions.

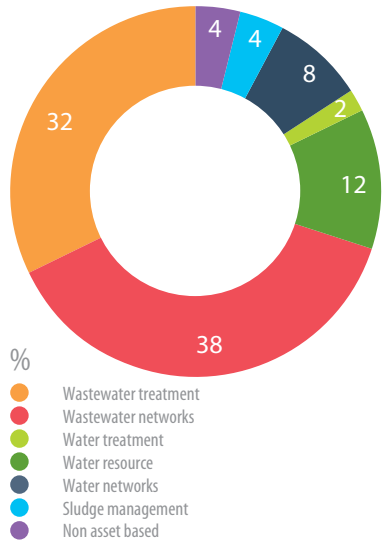
Table 1: Welsh Water's strategic risks and impacts

Function	Asset level	Climate variable	Primary impact of climate variable	Potential impacts on organisation and stakeholders
WASTEWATER TREATMENT	Treatment works	Drought	‣ Lower average and peak flow ‣ Lower river flow and increased seasonal variability	‣ Tighter discharge consents ‣ Pollution incidents ‣ Reed beds dry out – unable to operate ‣ Increased septicity – odour problem
	Treatment works & outfalls	Flood	‣ Direct asset flooding (including power supply) ‣ Increased flow to the Full Treatment ‣ Increased intense rainfall events and higher average flow ‣ Longer retention of water in storm tank ‣ Higher peak level at discharge point	‣ Complete service failure due to loss of asset or power outages. ‣ Increased risk of discharge consent failure ‣ On-site storm tank spillage.
	Treatment works	Sea level rise	‣ Direct asset flooding, storm damage and coastal erosion	‣ Asset loss and service failure
	Treatment works & outfalls	Temperature rise	‣ Higher average and peak temperatures affect structures, buildings, etc ‣ Greater microbial action increases gas production ‣ Reduced dissolved oxygen in receiving water courses	‣ Impact on UV plant, blowers, and bearings – service failure is possible. ‣ H&S risk – greater risk of ignition as gas production increases ‣ Discharge consent failure, pollution incidents, and tighter consents.
WASTEWATER NETWORKS	Sewer network & rising main	Drought	‣ Lower precipitation ‣ Lower average peak flow	‣ More frequent sewer blockages and increased customer flooding ‣ Asset deterioration - collapses are happening now in the system, attributable to hydrogen sulphide.
	All wastewater network including trunk sewers, pumping station, intermittent discharges	Flood	‣ Direct asset flooding, including power supply ‣ High rainfall intensity ‣ Increased volume of storm water ‣ High groundwater level	‣ Service failure - asset loss, customer flooding ‣ Power outages ‣ Reduced receiving water quality ‣ Increased spill frequency from intermittent discharges – potentially fail the discharge consent limit
	All wastewater network including trunk sewers, pumping station, intermittent discharges	Sea level rise	‣ Direct asset flooding, storm damage, coastal erosion or planned retreat ‣ High rainfall during high tide ‣ Tide locked intermittent discharges	‣ Service failure – asset loss, customer flooding ‣ Reduced receiving water quality.
	Sewer networks including trunk sewers, pumping station, and rising main	Temperature rise	‣ More extreme wetting and drying cycles ‣ Greater septicity.	‣ Asset deterioration results in customer flooding ‣ Increased odour issue.
SLUDGE MANAGEMENT	Sludge disposal &recycling	Flood	‣ Prevent access to land to dispose of sludge	‣ Unable to continue the service
WATER TREATMENT	Treatment works	Flood	‣ Direct asset flooding ‣ More intense rainfall events ‣ Increased runoff	‣ Increased drinking water quality risks ‣ Asset loss and services failure
	Service reservoir & water towers	Temperature rise	‣ More extreme wetting and drying cycles	‣ Increased burst frequency
WATER NETWORKS	Distribution storage	Flood	‣ Direct asset flooding	‣ Increased water quality risk
	Distribution storage & network ancillaries	Temperature rise	‣ More extreme wetting and drying cycles ‣ Higher peak demand	‣ Increased burst frequency ‣ Reduced security of supply
WATER RESOURCE	All water resource assets	Flood	‣ More frequent storms and power supply flooding	‣ Service failure due to power outages.
NON ASSET BASED	All assets & functions	Freeze (extreme winter condition)	‣ Unable to move fleet to site ‣ Impact on transportation	‣ If prolonged, service failure can be expected
	All assets & functions	All	‣ Loss of power – critical to business	‣ If prolonged, service failure can be expected

Section 4.1 provides more information on key measures that we currently have in place or plan to take which will build our adaptive capacity and resilience to a changing climate.

Our risk assessment seeks to highlight areas where Welsh Water should give priority in developing new or additional adaptation measures. The diagram below shows that the key priority areas are wastewater networks and wastewater treatment functions. As mentioned above, although there are some measures in place to reduce risks in these two functions, the number of impacts with high risk level (risk level of 6 and 9) is still significantly higher than other functions.

SCALE OF REMAINING HIGH PRIORITY RISKS, TAKING INTO ACCOUNT EXISTING MEASURES.



3.3 OPPORTUNITIES DUE TO THE EFFECTS OF CLIMATE CHANGE

Predictions indicate that climate change impacts will exacerbate the stress on water supply, particularly in south and east England (CEH, 2010). Our risk assessment suggests that there may be an opportunity for Welsh Water to sell more of our water supply to other parts of the UK. However, we recognise this could reduce the available water supply for our existing customers unless new or extended reservoirs were provided in our area. Although this potential opportunity has been identified through our risk assessment, we recognise that it raises significant environmental and political sensitivities. It is therefore not a policy we would develop without appropriate consultation with stakeholders, including with the Welsh Assembly Government and relevant regulators.

Similar to the result highlighted in Defra's CCRA – the Sectors Summary Report (2010), our assessment confirms that the predicted wetter winters could mean an opportunity for greater water storage during winter and increased hydro-power production as winter water flow increases. The increase in temperature may increase efficiencies in water, wastewater and sludge treatment processes.

4. ACTIONS PROPOSED TO ADDRESS RISKS

4.1 MEASURES ALREADY IN PLACE

Given the essential nature of the services we provide, responding to incidents and emergency planning are well established and rehearsed in most parts of our business. Some of these emergency plans are generic, so would be relevant whatever the cause of the emergency. For example, our plans set out procedures for the business to follow when the absence of staff poses risks to our operation. We have procedures in place if any deterioration in the quality of our drinking water supplies is detected through our extensive statutory monitoring programme or reports from customers. Welsh Water also has a drought plan in place which is underpinned by various powers available to us, e.g. to restrict the non-essential use of water. We have stand-by generators at our critical assets to provide energy in the event of a power failure, although they would represent only a comparatively short term measure.

Most predictions about the future changing climate anticipate drier and warmer summers, which will put an added strain on water resources. This will, in turn, increase the priority given to water efficiency. We have already reduced the leakage from our pipework by nearly 50% and have achieved a 25% fall in abstractions during the last ten years. Welsh Water is firmly committed to water conservation and promoting water efficiency and we continue to look for ways to improve our performance still further.

Particularly for our Water Resource Management Plan, Welsh Water has been the first water company in the UK to assess the implications of UKCP09 projections on its water resources activities. A briefing on our Water Resource Management Plan is provided in Appendix II to this report.

Welsh Water's SWEAR (Surface Water Elimination and Reduction) initiative includes local forums to bring together those organisations with an interest in the management of surface water, e.g. the Environment Agency, local authorities, developers and residents. We are hoping that in this way we will be able to achieve a local consensus about the best way to tackle local drainage problems.

Welsh Water is a partner in the European Union's 'PREPARED – Enabling change' project. The project's aim is to develop strategies to meet the future changes in water supply, sanitation and drainage that will be brought about by climate change. Lasting four years (March 2010 – 2014), the project involves 35 partner organisations, mainly involved in urban utilities in Europe, Australia and America. The project will receive around €7 million in a financial contribution from the EU. In its role as a partner organisation, Welsh Water will look at developing capacity for adaptable water systems. There will also be involvement in wider aspects of case study work used to evaluate the tools being developed in the project. Welsh Water is the only UK water company involved, and is being tasked to consider the adaption of water supply and sanitation systems to cope with climate change. The results will feed into the strategies which include water resource planning and surface water management. See http://www.prepared-fp7.eu for more detail.

Our drinking water safety plans will help to embed measures to tackle problems caused by a changing climate. They are based on a comprehensive risk assessment and risk management approach to all the steps in a water supply chain from catchment to consumer.

We took part in the PACT self-assessment, Defra's project which assesses the status of adaptive capacity in the UK water sector (the summary report is provided in Appendix III). The assessment forms part of the on-going UK CCRA project. PACT identifies six levels of responses, each response level represents an increase in complexity and also the capacity of an organisation to deal with climate change (Alexander Ballard Ltd, 2010). The self-assessment concluded [6] that Welsh Water has embedded climate change into our core business and that we are responsive to our stakeholders' requirements (policy and statutory requirements).

The result also indicated that we are making progress toward ensuring that effective management programmes are in place to improve the ways we deal with climate change and that we are proactive in developing innovations which improve our adaptive capacity, such as our Surface Water Reduction Strategy and SWEAR initiative.

The assessment has suggested that, as a target for our organisation, Welsh Water needs to work towards understanding major threats so that options can be identified and programmed to ensure resilience to a changing climate. We believe this is what we are doing now, and more work will be done as part of our asset management planning process.

The highest response level PACT identifies is to be a champion organisation, leading wider society in delaying and reversing the climate change impact. This is an aspiration that fits well with our strategic objectives set out in our Strategic Direction Statement (Section 1.1). We are keen to work alongside our regulators and key stakeholders in preparing Wales and the UK water sector for a changing climate, for example through our Water Resource Management Plan, our involvement with the Water UK, the EU 'PREPARED – Enabling change' project, and our membership of the Climate Change Commission for Wales' Adaptation Sub-group.

4.2 IMPLEMENTATION OF FURTHER ADAPTATION ACTIONS

As regards physical changes to individual assets, designing adaptation measures that would be appropriate for all of them is less than straightforward. Welsh Water operates many hundreds of assets of varying size and complexity. Assets have been designed according to site-specific characteristics. This means that, as potential impacts from climate change vary in different locations, it is impractical to identify general adaptation actions and their associated costs without further localised specific studies. This was recognised in a report commissioned by the Environment Agency (ICF International & RPA, 2007) [7], which accepted that the water industry's assets are difficult to characterise in broad generic terms.

[6] This self-assessment review process has not been moderated for its accuracy. Alexander Ballard Ltd's conclusion is based solely upon Welsh Water's answers in the assessment questionnaire, and not upon any other former knowledge of our organisation.

[7] 'The potential costs of climate change adaptation for water industry' (2007) is a report by ICF International and Risk Policy Analysts for the Environment Agency. The report took into account the UK Climate Impacts Programme 2002 Projections (UKCIP02).

Going forward, high priority risks identified by our risk assessment (Section 3) will be communicated to colleagues dealing with the relevant functions within Welsh Water. This is to ensure that further detailed assessment can take place to identify necessary and suitable adaptation actions in response to the risks. In effect, this will form part of our existing business planning process, where other risks are also identified and assessed (including cost-benefit analysis) to inform our future business plans, including our asset management plan for 2015-2020.

4.3 EMBEDDING ADAPTATION INTO OUR ORGANISATION

The report commissioned by the Environment Agency from ICF International & RPA (2007) suggested that the development by water companies of strategies and decision frameworks should be the focus of their adaptive approach. Effective strategies and decision frameworks should then drive tailor-made local solutions for site-specific consequences of climate change.

Welsh Water has been developing a number of 'process based' [8] adaptation actions. These include the company's key strategies, plans and other documents which set out our high level policies, approved by the company's board. The implementation of these plans should ensure that we embed building our adaptive capacity into our organisation. These key documents include: -

- Strategic Direction Statement
- Sustainability policy
- Carbon route map [9] and Carbon Reduction Commitment
- Energy policy and renewable energy strategy
- Water Resource Management Plan
- Water Efficiency Strategy
- Surface water management strategy

A brief overview of the existing 'process based' measures highlighted above is provided in Appendix IV to this report. The table below illustrates the relevance of the above documents to our adaptive capacity in the seven asset based functions.

EXISTING PROCESS BASED ADAPTATION MEASURES AND THEIR BENEFIT FUNCTIONS.

	Key based functions						
Existing measures	Water resource	Water treatment	Water networks	Wastewater networks	Wastewater treatment	Sludge	Site wide
Strategic Direction Statement	✓	✓	✓	✓	✓	✓	✓
Sustainability policy	✓	✓	✓	✓	✓	✓	✓
Carbon route map and CRC	✓	✓	✓	✓	✓	✓	✓
Energy policy and renewable energy strategy	✓	✓	✓	✓	✓	✓	✓
Water Resource Management Plan	✓		✓				
Water Efficiency	✓	✓	✓	✓	✓	✓	✓
Surface water management strategy				✓	✓	✓	✓

[8] Defra's statutory guidance highlighted two sorts of adaptation actions. Firstly, process based adaptation actions are the adaptation responses that authorities will undertake, especially in the first instance, to plan for adaptation. Secondly, outcome based adaption actions are generally illustrated by physical examples but it can also include non-physical actions.

[9] Our carbon route map document is currently in draft stage, it is yet to be issued to the business.

4.4 COSTS OF PLANNED ACTIONS

The above key strategies and policies have and will guide us in formulating our business plans in the future. They have already identified specific high priority projects and outcomes to be delivered in our current asset management plan for the next five years 2010-2015. These include

- £0.65 million has been identified by the Water Resource Management Plan to address supply-demand balance issues. This is in addition to the £5.77 million planned for other water resource projects.

- The increased rainfall in some catchments is already affecting the quality of our water resource. In response, around £140 million has been allocated to improve our treatment processes to ensure we meet statutory standards and so protect public health.

- £14 million has been identified for the surface water elimination and reduction pilot projects. This will be supported by additional funding from the Welsh Assembly Government of around £6 million. Alongside this investment, we have launched the Green Space Wales initiative. These initiatives aim to promote natural drainage to help the sewerage network cope better with climate change and increasing urbanisation to reduce incidents of sewer flooding.

- £45 million investment is planned for advanced digestion projects at three wastewater treatment works (in addition to £43 m million already invested in the previous asset management planning cycle). Energy produced from these projects is used to power the operation of assets on site and, where excess is available, supply to the national grid.

- £1.7 million for improving flood resilience for some of our clean water assets i.e. water treatment works and water pumping stations.

Despite the investigations we have undertaken and the investment we have made so far, we recognise that we have not fully assessed the potential impacts of climate change on all aspects of our business so we feel that we are still in an early stage of integrating climate change into our business.

Based on process based adaptation actions, including the preparation of this report, we plan to build our adaptive capacity and identify specific outcome based adaptation actions. This may encompass:

- The proposed actions identified by the risk assessment/ scoring undertaken to inform this report;

- Adopting the approach used for Water Resource Management Plan in some other parts of the business to identify relevant climate change impacts;

- Raising awareness among staff, contract partners and suppliers;

- Engaging in discussion and working with others to share ideas and identify suitable actions. This will include other water companies (through Water UK), research bodies such as UK Water Industry Research (UKWIR) and our regulators.

5. UNCERTAINTIES AND ASSUMPTIONS

There are inherent uncertainties in the process of assessing the risks (and opportunities) associated with climate change and determining appropriate adaptation measures.
These uncertainties arise from:

- Uncertainties in projecting climate change: although UKCP09 indicates the extent of much of the uncertainty inherent in climate modelling, there is additional uncertainty relating to which greenhouse gas emissions scenario will turn out to be the most likely global outcome, given international actions to mitigate the causes of climate change, and uncertainty related to natural climate variability.

- Uncertainties in translating changes in climate into weather trends and the future severity and frequency of extreme events: the uncertainty inherent in climate science propagates through the modelling of changes in climate variables on future floods, droughts and storms.

- Uncertainties in determining the best set of adaptation measures and the implementation programme: the uncertainty inherent in these propagates through the risk-based assessment and decision-making processes involved in evaluating adaptation options.

These uncertainties in climate science are reflected in UKCP09's probabilistic approach, which includes three different emission scenarios. We – like the Welsh Assembly Government – have used the medium scenario, but the uncertainty associated with using only one emission scenario is acknowledged.

Exactly where and when climate change impacts will occur is also uncertain, making it difficult to know when we need to invest in further adaptation.

There is inevitable subjectivity in our risk scoring processes and much of our assessment is at a very high level. Another significant assumption we took during risk assessment is that all our existing measures, mitigation and adaptation, will be delivered on time and that they will be effective and efficient as planned i.e. we assume they will reduce the risk level as expected. In reality, we cannot be certain this is the case as there are factors outside of our control that could affect the delivery and effectiveness of our measures.

As ICF international and RPA highlighted in their report to the Environment Agency (2007), it is difficult to be precise about the likely costs of adaptation for water industry, principally because climate change will not be the only factor that drives decision-making about water industry investment. It is also clear that a rigorous process of option appraisal would be required to judge cost-effective adaptation measures for the water industry.

In view of the above, we do not consider that much can be done to reduce the above uncertainties at this stage. We recognise that further analysis will be required to enable us to identify risks and impacts with greater confidence.

6. BARRIERS TO, AND INFLUENCES ON ADAPTATION, INCLUDING INTERDEPENDENCIES

6.1 BARRIERS AND WIDER INFLUENCES

According to the ICF International & RPA's report, it would cost Welsh Water around £500 million (based on the study in 2007) to invest in increasing storage capacity as an adaptation action to address the potential impact on our wastewater network[10]. To put this into perspective, this would be almost a third of our investment programme for the current five-year asset management plan (a total of around £1.3 billion) which covers all aspects of our business. To spend £500 million just on increasing storage capacity would compromise our ability to deliver to our customers the services they expect at an affordable price. Besides, we do not consider that providing ever increasing storage capacity is a sustainable approach in adapting to climate change, hence our drive to find sustainable alternatives.

As noted in Section 1.4, Ofwat, our statutory financial regulator, sets the limits on the prices we may charge our customers. This means that Ofwat can, in effect, rule out investment, including planned expenditure on climate change adaptation. Having said that, Ofwat has allowed us to proceed with our climate change related investment during 2010-2015. Ofwat is encouraging water companies to think beyond the usual five year investment cycles and so asked companies to produce strategic direction statements covering the next 25 years. Ofwat is also providing the industry with a steer as regards priorities for climate change investment.

Any credible plan to adapt to climate change must look beyond a single organisation, or even a single sector. Joint action is much more likely to be successful. In this respect, the Welsh Assembly Government can perform an important leadership role and encourage 'joined up' action by relevant organisations in Wales. The Welsh Assembly Government is the major funder of much of the public sector in Wales so exercises considerable influence over it and the Assembly Government also seeks to foster good relationships with the private sector.

The Welsh Assembly Government has certainly tried to use the levers available to it in this way. In its 'One Wales' document, published in 2007, which sets out the agreement unpinning the current government coalition, the Welsh Assembly Government acknowledged that "Climate change is the greatest threat facing humanity". It therefore undertook to establish a Climate Change Commission for Wales chaired by the Environment Minister and said that the Welsh Assembly Government would aim to achieve annual carbon reduction-equivalent emissions reductions of 3% per year by 2011 in areas of devolved competence.

Also in 2007, the Welsh Assembly Government launched a consultation on an action plan to adapt to climate change. Subsequently, in 2009, the Assembly Government issued its high level policy statement on climate change. All of these were brought together in the Climate Change Strategy for Wales, which was published in October 2010.

[10] Total cost of increasing storage capacity as an adaptation action was estimated at over £15 billion, with estimated annual cost requirement of between £0.9 billion to £1.1 billion.

Welsh Water acknowledges the genuine commitment that the Environment Minister, Jane Davidson, brings to this issue and her efforts to raise the profile in Wales of climate change. Welsh Water has supported the Welsh Assembly Government's initiatives in this area, e.g. by providing a case study for its climate change strategy programme of action consultation.

The Welsh Assembly Government has also sought to use its influence – statutory and otherwise – to encourage climate change to be taken into account in the water industry in Wales. A good example is its statutory Social and Environmental Guidance to Ofwat (2008), in which the Welsh Ministers called on Ofwat to "support water companies in developing long term, sustainable solutions to these new (climate change) challenges. This will include encouraging innovative approaches and new ways of tackling issues." In the section about adaptation, the document says, for example, that "the Assembly Government expects water companies to take steps to adapt to future climate change." Its 2009 Strategic Policy Position Statement on Water also acknowledged that "Climate change will cause fluctuations in the availability of water with more extreme dry spells and flooding events placing unprecedented demands on the system while society and businesses expect consistent availability of water services".

Looking ahead, the Welsh Assembly Government has signalled its wish for climate change to inform wider policy areas in Wales in its recent publications on flood risk management and in 'Living Wales', its proposals for a natural environment framework.

Climate change is only one of many challenges that our industry faces. For example, we must comply with many European and national laws. These standards, which are enforced by our regulators, affect many aspects of our business. By way of illustration, stringent standards are (rightly) prescribed for drinking water quality and, as noted above, this increases our reliance on supplies of requisite chemicals. The aquatic environment is also subject to a raft of obligations: there are European rules governing the minimum standards of treatment we must provide to most discharges of effluent, and setting quality standards for waters used for bathing or those that support freshwater fish or shellfish. These rules severely constrain our options as regards the location and levels of treatment we give to discharges of waterwaste.

Of particular note is the European Water Framework Directive. As it is a 'framework' Directive, it is less prescriptive than previous water related Directives and so gives Member States some flexibility in its implementation. Having said that, it has the very ambitious goal of delivering a water environment that deviates only slightly from those normally associated with undisturbed conditions.

Welsh Water is totally dependent on the continued high quality of the aquatic environment so we are generally very supportive of the Directive's objectives. However, it needs to be implemented in a sensible way: it would be disappointing and counterproductive if, for example, inappropriate implementation of the Water Framework Directive jeopardised worthwhile hydroelectric schemes, or led to increased energy use to achieve marginal water quality improvements.

Many watercourses in Wales are designated under the Habitats Directive in recognition of their conservation importance. These include many rivers from which Welsh Water abstracts water to be treated for supply as drinking water. We are under a statutory duty to conserve flora and fauna and we are keen to minimise our impact on important species and habitats. However, some environmental standards arising from Habitats Directive are overly precautionary (often because of the lack, or poor quality, of data) and fail to take account of the inevitable impact of climate change. Too rigid an approach to the Habitats Directive could jeopardise the security and affordability of future drinking water supplies, whilst also failing to provide proper protection of vulnerable species in the long run.

We hope that the UK Government will seek to influence future European policy and persuade its European partners of the overarching need, in terms of environmental policy, to respond to climate change.

If we are to ensure that our sewers do not cause localised flooding and environmental damage as a result of becoming overloaded, we need to have full control over them. This is likely to become even more critical in the face of the increased storminess predicted as part of climate change. A recent Supreme Court judgment reinforced the developer's right to connect at a point to be determined by the developer rather than the sewerage undertaker, regardless of any adverse impacts.

The Court held that control over a sewerage undertaker's assets effectively rests with the local planning authority. Sewerage undertakers are currently not even statutory consultees under planning legislation.

The UK and Welsh Governments have announced plans to transfer the ownership of private sewers in England and Wales to water and sewerage undertakers. We estimate that this will increase by approximately 90% the length of sewer for which Welsh Water is responsible. To make matters worse, as they were previously unadopted, the transferred sewers are unlikely to be constructed to the standards we would normally require and thus pose a higher risk of causing flooding and pollution.

6.2 INTERDEPENDENCIES

Welsh Water regularly takes part in emergency planning exercises which help us to prepare for major service disruptions. It also helps us to foster good working relationships with other relevant emergency responders.

The water industry depends on the availability of infrastructure provided by the energy, transport and communication sectors. The highly interconnected dependencies between these sectors and the water sector are highlighted in Adapting Energy, Transport, and Water Infrastructure to the Long-Term Impacts of Climate Change (2010), a report commissioned by Defra.

Our operation, particularly water and wastewater treatment, tends to be energy intensive making us very reliant on the availability and affordability of energy supply to operate our assets. Our offices and information technology also rely on the availability of electricity. We need an accessible transportation network for our staff to travel to and from their work locations including where our asset needs repair and maintenance. A transportation network is also necessary to keep us supplied with the chemicals etc that we require and for the management of our wastes, particularly to remove wastes off-site, including sludge disposal. We require Information and Communication Technology (ICT) to communicate with our staff and to efficiently manage our day-to-day business and operations. Such ICT systems include telephones, intranet, internet and telemetry systems.

Business contingency planning, including alternative on-site energy supply, may reduce short term impacts of the failure of other sectors. However, we acknowledge that we need to give further consideration to how we would manage the impacts of failures that lasted for a longer term period. We would be interested to see the adaptation reports from the other relevant sectors and would welcome an opportunity to discuss with them how best we can collaboratively adapt to climate change.

We also acknowledge that the delivery of some of our adaptation measures, particularly our efforts to improve surface water management, relies on local authorities playing their full part.

7. MONITORING AND EVALUATION

On a day-to-day basis, we monitor the quality of the 'raw' water we abstract prior to treatment and supply as drinking water. This ten year data set has already shown trends which seem to demonstrate deteriorating quality in some areas caused by changing rainfall patterns, and it will continue to serve that purpose. We are also introducing more monitoring of the volumes of water in our wastewater network which should improve our understanding of the pressures on that system and so help inform future investment decisions.

As mentioned previously, Welsh Water does not intend to consider risks posed by climate change in isolation from other risks relevant to our functions. This means that the progress and success of existing and future climate change adaptation actions will be monitored and evaluated as part of our existing asset management planning process.

Having said that, with reference to UKCIP's Risk, Uncertainty and Decision-Making Framework (Willows & Connell, 2003), we can identify two areas where we will monitor and evaluate to ensure climate change is adequately embedded in our organisation

Firstly, we will aim to periodically review and develop our climate change impact risk assessment process. We believe that as more information becomes available and the potential impacts of climate change are further communicated throughout our business, the level of confidence in risk assessment will improve. Consequently, this will better inform our business planning process of necessary adaptation actions.

Secondly, the delivery of existing and future adaptation actions will be monitored and evaluated. This will form part of our existing asset management planning process. This process, which underpins the periodic review of water price limits, ensures that every five years we must undertake a full review of our serviceability including future challenges. It makes sense for us to factor the most up to date climate change projections and predictions into this planning process. This substantial exercise is done in close liaison with our statutory regulators who let us know their priorities for our future investment. Given the long life of our assets, Welsh Water actively encourages our regulators to take account of climate change in providing their advice.

Every year Ofwat closely scrutinises our performance to check that we have provided the projects we have previously included in our asset management plans and that the investment has been completed on time. We are penalised if we fail to do so. For example, the delivery of our surface water reduction schemes and flood resilience programme (mentioned in Section 4) will be monitored and evaluated as part of this process.

In addition to the above, the Water Framework Directive includes a six year planning cycle, established through statutory River Basin Management Plans prepared by the Environment Agency. Defra and the Welsh Assembly Government have issued statutory guidance to the Agency which advises that climate change must be taken into account in the Plans. The Agency has produced initial Plans which will be replaced in 2015: no doubt the Agency will wish to review the impact of climate change before issuing new Plans for Wales.

We acknowledge that the preparation of this report into climate change adaptation has been a useful exercise. We intend to keep this report under review so that, for example, any improvements in our understanding of the potential impact of climate change can be fed into our risk assessments.

In particular, we note that the Welsh Assembly Government's recent 'Climate Change Strategy for Wales' says *"Before publication of the UK Climate Change Risk Assessment in 2012, we do not intend to require Reporting Authorities in Wales to prepare and submit adaptation reports."* We will review this document when we receive a formal request from the Welsh Government to prepare an adaptation report.

References

Alexandar Ballard Ltd. (2010). PACT. climate change adaptation self-assessment summary report for Dŵr Cymru Welsh Water. Defra.

CEH. (2010). The water resource sector report (Phase 1 report to the Climate Change Risk Assessment).

Dŵr Cymru Welsh Water. (2007). Strategic Direction Statement.

Dŵr Cymru Welsh Water's Surface Water Management Strategy.

Dŵr Cymru Welsh Water. (2008). Final Draft Water Resource Management Plan.

Dŵr Cymru Welsh Water's Final Water Resource Management Plan, not yet published.

Dŵr Cymru Welsh Water's Final Business plan for the 5th Asset Management Plan cycle (AMP5).

ICF International & RPA. (2007). The potential costs of climate change adaptation for water industry. Commissioned by the Environment Agency.

MWH. (2007). A climate change adaptation approach for asset management planning. Water UK.

Met office. (2010). Changes in the frequency of extreme rainfall events for selected towns and cities. Ofwat.

National Assembly for Wales. (2000). Summary report: Wales – Changing climate, challenging choices.

Ofwat. (2007). Understanding Ofwat: Glossary of the most commonly-used Ofwat terms.

URS Corporation Ltd. (2010). Adapting energy, transport and water infrastructure to the long-term impacts of climate change. Commissioned by Defra.

Welsh Assembly Government. (2007). One Wales – A progressive agenda for the government of Wales.

W**elsh Assembly Government. (2008)**.Social and Environmental Guidance to Ofwat.

http://wales.gov.uk/topics/environmentcountryside/epq/waterflooding/

Welsh Assembly Government. (2009). Strategic Policy Position Statement on Water.

http://wales.gov.uk/topics/environmentcountryside/epq/waterflooding/policystatement/

Welsh Assembly Government. (2010). Economic Renewal: A New Direction.

Welsh Assembly Government. (2010). Climate Change Strategy for Wales.

Willows, R.I. and Connell, R.K. (Eds). (2003).
Climate adaptation: Risk, uncertainty and decision-making. UKCIP Technical Report. UKCIP, Oxford.

Appendix I - Risk Register Table

						INITIAL RISK LEVEL				RESIDUAL RISK LEVEL				
ASSET FUNCTION	ASSET LEVEL 3	CLIMATE VARIABLE	DESCRIPTION	PRIMARY IMPACT OF CLIMATE VARIABLE	IMPACT ON SERVICE	Level of Impact	Level of likelihood	Level of risk	COMPANY'S EXISTING ADAPTIVE ACTIONS	Level of Impact	Level of likelihood	Level of risk	COMPANY'S PROPOSED ACTION TO REDUCE RESIDUAL IMPACTS	Additional note from workshop
WR	All Water Resources	DROUGHT	Reduced available supply causes political pressure for essential water users, e.g schools and hospitals, and for other customers **reduces security of supply**	Reduced available supply	Reduced security of supply	2	3	6	Security and Emergency Measures Direction (1998); completion of DCWW 'Additonal Services' form and return to DCWW; appointment of Additonal Needs Manager in drought, as outlined in Drought Plan. Usual Drought Plan procedures and mitigation measures in place; WRMP ensures SoS over the planning period (to 2036), **including** under UKCP09.	2	1	2		
WR	All Water Resources	DROUGHT	Daily & peak demand for 'garden' watering increases, causing **a reduction in security of supply**	Higher daily & peak demand for garden watering,	Reduced security of supply	2	3	6	WRMP - demand forecasting, demand management elements all covered and linked to company policies & actions. SDB derived taking into account the aforementioned and including UKCP09 (DCWW pioneering the water industry). DCWW 'Water Efficency Strategy' - which is inherently included in the WRMP. DCWW metering startegy included in the WRMP/ demand forecasts (by 2035 approx 70% of households will be metered).	2	2	4		
WR	All Water Resources	DROUGHT	Lower river yields, borehole yields or reduced water quality lead to abstraction licences being reduced or removed, causing a **reduction in security of supply**	Lower river & borehole yields or reduced water quality	Abstraction licences reduced or removed, reducing security of supply	3	3	9	WRPM. DP. Leakage management. New mains for conjunctive use. Emergency planning. Tankering.	2	1	2		
WR	All Water Resources	DROUGHT	Increased customer sensitivity to possibility of service failure **impacts security of supply.**	Drier conditions	Reduced security of supply	2	2	4	WRMP, Drought Plan, WE Strategy - high profile publication and education required	1	1	1		
WR	Storage Reservoirs & Aqueducts	DROUGHT	Lower river flows reduce yields and hence increased demand on existing storage, and causes a **reduction in security of supply**	Lower river flows	Reduced security of supply	3	3	9	WRMP - impacts of UKCP09 directly included on SDB components (DO, mitigation options) and full range of UKCP09 included in SDB Target Headroom (uncertainty). Resulting deficit WRZ's subjected to mitigation options to restore supply-demand balance (funding through FBP process).	1	2	2		
WR	Boreholes / source pumping stations	DROUGHT	Lower groundwater levels reduce borehole yields and causes a **reduction in security of supply**	Lower groundwater levels	Reduced security of supply	2	3	6	Education? Where is this from? See answer provided above.	1	2	2		
WR	Raw water pipelines	DROUGHT	Lower flow rates cause deposition leading to **reduced raw water quality**	Lower flow rates	Reduced raw water quality	1	1	1	Unsure what this question is leading to. In Drought, the demand will be approximately the same (even after WE Strategy/ messages). DP and WRMP should ensure suffcient quantities are availlable through the most severe drought (on record), therefore 'deposition' shouldnt be an issue.	1	1	1		
WR	Intake Pumping stations	DROUGHT	River levels fall and they become less reliable sources, **reducing security of supply**	River levels fall	Reduced security of supply	3	3	9	WRMP and the associated UKCP09 modelling/ inclusion; intervention options for predicted deficit zones.	1	2	2		
WR	All Water Resources	FLOOD	Direct asset flooding causes **service failure and asset loss**	Direct asset flooding	Asset loss and service failure	3	3	9	Flood resilience plan. Reslience of WRMP ensures conjunctive use/ alternate supplies.	2	2	4		
WR	Intake Pumping stations	FLOOD	Greater volumes of storm water cause increased pumping where pumps are part of the infrastructure, leading to increased asset usage and **accelerated asset deterioration**	More storm water	Increased asset useage and accelerated asset deterioration	1	1	1		1	1	1		similar risks are scored at the workshop. To allow correct calculation - scores are determined post workshop
WR	All Water Resources	FLOOD	Increased storm frequency and power supply flooding increases frequency of power loss, causing **service failure**	More frequent storms and power supply flooding	Power outages and service failure	3	3	9	Uninterrupted power supply	2	3	6		
WR	All Water Resources	FLOOD	Flooding in certain areas causes redistribution of permanent population (eg away from flood plains) and tourism, which affects demand and **impacts on security of supply**	Movement of permanent population (eg away from flood plains) and tourism due to flooding,	Impacts on security of supply	1	1	1	WRMP includes the very latest demand forecasts. WRMP updated every 5 yrs, so should pick up this longer term population migration.	2	1	2		
WR	All Water Resources	FLOOD	The threat of treatment works being flooded (with subsequent service loss) **increases customer expectations for visible hard engineering adaptation solutions**	The threat of assets being flooded	Increased customer expectations for visible hard engineering adaptation solutions	1	1	1		1	1	1		
WR	Storage Reservoirs & Aqueducts	FLOOD	Increased soil erosion causes the siltation of dams, causing **accelerated asset deterioration** and **asset loss**	Increased soil erosion	Accelerated asset deterioration and loss	1	3	3	Ongoing period bathymetric surveys of reservoirs and review process of WRMP (5 yrs) will account for this.	1	1	1		
WR	Storage Reservoirs & Aqueducts	FLOOD	More intense rainfall events & changes to soil conditions lead to the slippage of soil dams**,** causing **service failure, customer flooding and asset loss**	More intense rainfall events & changes to soil conditions	Service failure, customer flooding and asset loss	3	1	3	10 yearly Reservoir inspections, under the Reservoir Act 1975. Also again, review process of WRMP (5 yrs) will account for this.	2	1	2		
WR	Storage Reservoirs & Aqueducts	FLOOD	More intense rainfall events exceed capacity of spillways to deal with increased storm intensity, causing **service failure, customer flooding and asset loss**	More intense rainfall events	Service failure, customer flooding and asset loss	3	1	3	Reservoirs covered by the Reservoirs Act 1975 (>25Ml) will have been designed to cope with flooding levels, based on category of dam (A, B or C); highest standard is 0.5x PMF (Probably maximum flood) or 1:10,000 yrs whichever is higher. The lowest standard, for category C, is 1:150 yrs. All categories will be accordingly protected. All dam break studies based on PMF.	2	1	2		
WR	Boreholes / source pumping stations	FLOOD	More intense rainfall events compact upper soil layers, increasing run-off, reducing recharge of aquifers and **reducing security of supply**	More intense rainfall compacting upper soil layers	Reduced security of supply	1	1	1	A 'intense' rainfall event to compact soil s a short term impact ie the majority of rainfall events will not be 'intense'. Aquifer recharge is long term, i do not see this being an issue.	1	1	1		
WR	Raw water pipelines	FLOOD	Flood water infiltration into pipelines **increases drinking water quality risk**	Flooding	Increased drinking water quality risk	1	1	1		1	1	1		
WR	All Water Resources	SEA LEVEL	Direct asset flooding, storm damage and coastal erosion or 'planned retreat' cause **service failure and asset loss**	Direct asset flooding, storm damage, coastal erosion or planned retreat	Service failure and asset loss	1	1	1	is this a Water Resources issue? WR dont have many coastal assets.	1	1	1	not applicable	

						INITIAL RISK LEVEL				RESIDUAL RISK LEVEL				
ASSET FUNCTION	ASSET LEVEL 3	CLIMATE VARIABLE	DESCRIPTION	PRIMARY IMPACT OF CLIMATE VARIABLE	IMPACT ON SERVICE	Level of Impact	Level of likelihood	Level of risk	COMPANY'S EXISTING ADAPTIVE ACTIONS	Level of Impact	Level of likelihood	Level of risk	COMPANY'S PROPOSED ACTION TO REDUCE RESIDUAL IMPACTS	Additional note from workshop
WR	All Water Resources	SEA LEVEL	Saline intrusion degrades infrastructure, causing **accelerated asset deterioration**	Saline intrusion	Accelerated asset deterioration	1	1	1	is this a Water Resources issue?	1	1	1	not applicable	
WR	All Water Resources	SEA LEVEL	Flooding in certain areas causes redistribution of permanent population and tourism (eg away from flood plains), which affects demand and **impacts on security of supply**	Movement of permanent population (eg away from flood plains) and tourism due to flooding	Impacts on security of supply	1	1	1	WRMP includes the very latest demand forecasts. WRMP updated every 5 yrs, so should pick up this longer term population migration.	1	1	1		
WR	Boreholes / source pumping stations	SEA LEVEL	Saline intrusion decreases yield, causing a **service loss** and **reduction in security of supply**	Saline intrusion	Service failure and reduction in security of supply	1	2	2	WRMP updated every 5 yrs, so will pick up this longer term issue and mitigate through intervention options.	1	1	1		
WR	Intake Pumping stations	SEA LEVEL	Tidal limits move upstream and lead to greater salinity at intakes, causing **raw water resource loss** and **reduction in security of supply**	Tidal limits moving upstream and increasing salinity at intakes	Reduced security of supply	1	2	2	WRMP updated every 5 yrs, so will pick up this longer term issue and mitigate through intervention options.	1	2	2		
WR	All Water Resources	TEMP. RISE	Higher average and peak temperatures affect structures, buildings, H & V, MEICA plant working life, **causing accelerated asset deterioration**	Higher average and peak temperatures	Accelerated asset deterioration	1	1	1		1	1	1		
WR	All Water Resources	TEMP. RISE	Redistribution of / increase in tourism increases seasonal demand and causes **a reduction in security of supply**	Redistribution of / increase in tourism	Reduced security of supply	2	3	6	WRMP includes the very latest demand forecasts. WRMP updated every 5 yrs, so should pick up this issue.	1	2	2		
WR	All Water Resources	TEMP. RISE	Daily and peak domestic and commercial demand increases, causing a **reduction in security of supply**	Higher daily and peak domestic and commercial demand	Reduced security of supply	2	3	6	WRMP includes the very latest demand forecasts. WRMP updated every 5 yrs, so should pick up this issue. Water Efficiency Strategy.	1	2	2		
WR	All Water Resources	TEMP. RISE	Higher temperatures and longer growing season causes redistribution of / increase in agricultural demand and **impacts on security of supply**	Higher temperatures and longer growing season	Impacts on security of supply	2	3	6	WRMP includes the very latest demand forecasts. WRMP updated every 5 yrs, so should pick up this issue. Water Efficiency Strategy. Joint working with EAW on promoting water efficient best practices (as part of WRMP).	1	2	2		
WR	All Water Resources	TEMP. RISE	Redistribution of permanent population in response to temperature rise affects demand and **impacts on security of supply**	Redistribution of permanent population with warmer conditions	Impacts on security of supply	2	3	6	WRMP includes the very latest demand forecasts. WRMP updated every 5 yrs, so should pick up this issue.	1	2	2		
WR	All Water Resources	TEMP. RISE	Increased customer sensitivity **impacts security of supply**	Higher temperatures	Impacts on security of supply	-1	2	-2		-1	2	-2	Opportunity	
WR	Storage Reservoirs & Aqueducts	TEMP. RISE	Increased evaporation and evapotranspiration reduce yields, causing a **reduction in security of supply**	Increased evaporation and evapotranspiration	Reduced security of supply	2	1	2	We are not predicted to live in the Sahara even under UKCP09 5%ile scenarios! WRMP updated every 5 yrs, so will pick up this longer term issue and mitigate through intervention options.	1	1	1		
WR	Storage Reservoirs & Aqueducts	TEMP. RISE	Increased evaporation and evapotranspiration reduces yield of surface reservoirs and increases demand on groundwater recharge, causing a **reduction in security of supply**	Increased evaporation and evapotranspiration	Reduced security of supply	2	1	2	WRMP updated every 5 yrs, so will pick up this longer term issue and mitigate through intervention options.	1	1	1		
WR	Boreholes / source pumping stations	TEMP. RISE	Increased evaporation and evapotranspiration reduce infiltration, and so borehole yields, causing a **reduction in security of supply**	Increased evaporation and evapotranspiration	Reduced security of supply	2	1	2	WRMP updated every 5 yrs, so will pick up this longer term issue and mitigate through intervention options.	1	1	1		
Water networks	All Water Networks	DROUGHT	Daily & peak demand for 'garden' watering increases, increasing asset use and causing **accelerated asset deterioration**	Higher daily & peak demand for garden watering	Accelarated asset deterioration	2	3	6	Education. Hose ban.	2	2	4		
Water networks	Distribution networks incl. ancillaries	DROUGHT	Loss of supply or intermittent supplies increases risk of external contaminants entering the pipelines, **increasing drinking water quality risk**	Loss of / intermittent supply	Increased drinking water quality risk	2	2	4		2	2	4		
Water networks	Distribution networks incl. ancillaries	DROUGHT	Loss of supply and de-pressurisation of pipelines leads to **greater incidence of pipe failure**, and resulting contamination during re-pressurisation **increases drinking water quality risk**	Loss of supply and depressurisation of the supply network	More frequent pipe failure and increased drinking water quality risk	2	2	4		2	2	4		similar risks are scored at the workshop. To allow correct calculation - scores are determined post workshop
Water networks	Distribution networks incl. ancillaries	DROUGHT	Loss of supply or intermittent supplies leads to increased risk of mechanical asset failure in PRV's, PSV's, Actuated Valves causing **service loss**	Loss of / intermittent supply	Increased risk of asset failure and service failure	1	1	1		1	1	1		
Water networks	Distribution pumping stations	DROUGHT	Loss of supply and de-pressurisation of the supply system leads to greater incidence of air blockages, causing **service failure**	Loss of supply and depressurisation of the supply network	Service failure	1	1	1		1	1	1		
Water networks	Distribution storage	DROUGHT	Lower flow rates cause deposition leading to **reduced raw water quality.**	Lower flow rates	Reduced raw water quality	2	1	2		2	1	2		similar risks are scored at the workshop. To allow correct calculation - scores are determined post workshop
Water networks	Distribution storage	DROUGHT	Loss of supply or intermittent supplies leads to contamination from accumulated silt and debris being flushed out of service reservoirs and towers, **increasing drinking water quality risk**	Loss of supply or intermittent supplies	Increased drinking water quality risk	1	1	1		1	1	1		
Water networks	All Water Networks	FLOOD	Direct asset flooding causes **service failure and asset loss**	Direct asset flooding	Asset loss and service failure	2	2	4		2	2	4		
Water networks	All Water Networks	FLOOD	Increased storm frequency and power supply flooding increases frequency of power loss, causing **service failure**	More frequent storms and power supply flooding	Power outages and service failure	2	2	4	Standy generators/UPS. Emergency Planning.	1	2	2		

						INITIAL RISK LEVEL				RESIDUAL RISK LEVEL				
ASSET FUNCTION	ASSET LEVEL 3	CLIMATE VARIABLE	DESCRIPTION	PRIMARY IMPACT OF CLIMATE VARIABLE	IMPACT ON SERVICE	Level of Impact	Level of likelihood	Level of risk	COMPANY'S EXISTING ADAPTIVE ACTIONS	Level of Impact	Level of likelihood	Level of risk	COMPANY'S PROPOSED ACTION TO REDUCE RESIDUAL IMPACTS	Additional note from workshop
Water networks	Distribution networks incl. ancillaries	FLOOD	Flood water infiltration into pipelines **increases drinking water quality risk**	Flooding	Increased drinking water quality risk	3	2	6		3	2	6		similar risks are scored at the workshop. To allow correct calculation - scores are determined post workshop
Water networks	Distribution networks incl. ancillaries	FLOOD	Direct flooding causes contaminants to enter pipelines, **increasing drinking water quality risk**	Direct flooding	Increased drinking water quality risk	3	1	3		3	1	3		similar risks are scored at the workshop. To allow correct calculation - scores are determined post workshop
Water networks	Distribution storage	FLOOD	Direct flooding causes contaminants to enter underground storage tanks **increasing drinking water quality risk**	Direct flooding	Increased drinking water quality risk	3	3	9		3	3	9		
Water networks	All Water Networks	GENERAL	Relocation of permanent and tourist population from drought, temperature rise, flooding or sea level rise (impacts D2, T2, T3, T5, F3, S2) changes supply-demand balance. Response chosen (within WR) **impacts water networks requirements and capacity needed.**	Relocation of population from weather, flooding, sea level rise	Impacts water network requirements and capacity and reduced security of supply	1	1	1		1	1	1		
Water networks	All Water Networks	SEA LEVEL	Direct asset flooding, storm damage and coastal erosion or 'planned retreat' cause **service failure and asset loss**	Direct asset flooding, storm damage, coastal erosion or planned retreat	Asset loss and service failure	1	1	1		1	1	1		
Water networks	All Water Networks	TEMP. RISE	Higher average and peak temperatures affect structures, buildings, H & V, MEICA plant working life, **causing accelerated asset deterioration**	Higher average and peak temperatures	Accelerated asset deterioration	1	1	1		1	1	1		
Water networks	Distribution networks incl. ancillaries	TEMP. RISE	Greater extremities in wetting and drying cycles lead to greater soil movement, causing pipe systems to move **increasing burst frequency**	More extreme wetting and drying cycles	Increased burst frequency	3	2	6		3	2	6		
Water networks	Distribution networks incl. ancillaries	TEMP. RISE	Increased rate of micro-biological growth increases risk of residual chlorine depletion and contamination of supplies, **increasing drinking water quality risk**	Increased micro-biological growth	Increased drinking water quality risk	2	3	6	Monitoring and cleaning. Secondary chlorination.	2	2	4		
Water networks	Distribution storage	TEMP. RISE	Increased peaks of demand lead to greater storage requirements **reducing security of supply**	Higher peak demand	Reduced security of supply	3	3	9		3	3	9		
Water networks	Distribution storage	TEMP. RISE	Increased rate of micro-biological growth increases risk of residual chlorine depletion and contamination of supplies, **increasing drinking water quality risk**	Increased micro-biological growth	Increased drinking water quality risk	2	3	6	Monitoring and cleaning. Secondary chlorination.	2	2	4		
WTWs	All Water Treatment	DROUGHT	Low flows lead to greater sedimentation, with blockages causing **service failure**	Low flows	Service failure	1	1	1		1	1	1		
WTWs	Treatment works	DROUGHT	Reduced raw water volumes reduce dilution and **increase drinking water quality risk**	Reduced raw water volumes reducing dilution	Increased drinking water quality risk	2	1	2		2	1	2		
WTWs	Service Reservoirs & Water Towers	DROUGHT	Loss of / intermittent supply increases risk of contamination from accumulated silt and debris being flushed out of service reservoirs and towers, **increasing drinking water quality risk**	Intermittency in supply	Increased drinking water quality risk	2	1	2	Cleaning programmes.	2	1	2		
WTWs	Service Reservoirs & Water Towers	DROUGHT	Loss of / intermittent supply increases risk of contamination from external contaminants entering the pipelines, **increasing drinking water quality risk**	Loss of / intermittent supply	Increased drinking water quality risk	2	2	4	Regulation inspection.	2	2	4		
WTWs	Service Reservoirs & Water Towers	DROUGHT	Loss of supply and de-pressurisation of pipelines leads to **greater incidence of pipe failure** with resulting contamination **increasing drinking water quality risk**	Loss of supply and de-pressurisation	More frequent pipe failure and increased drinking water quality risk	2	2	4		2	2	4		
WTWs	Service Reservoirs & Water Towers	DROUGHT	Inversions occur more frequently in incidences of low water levels; Cryptosporidium accumulation issues **increase drinking water quality risk**	Inversions occur more frequently with low water levels;	Increased drinking water quality risk	1	1	1		1	1	1		
WTWs	Treated water pumping stations	DROUGHT	Loss of supply and depressurisation of the supply system leads to greater incidence of air blockages, causing **service failure**	Loss of supply and depressurisation of the supply network	Service failure	2	2	4		2	2	4		
WTWs	All Water Treatment	FLOOD	Direct asset flooding causes **service failure and asset loss**	Direct asset flooding	Asset loss and service failure	3	3	9	Flood resilience plan.	3	2	6		
WTWs	All Water Treatment	FLOOD	Increased storm frequency increases frequency of power loss, causing **service failure**	More frequent storms and power supply flooding	Service failure	3	3	9		3	2	6		similar risks are scored at the workshop. To allow correct calculation - scores are determined post workshop - take into account simiar risks with score.
WTWs	Treatment works	FLOOD	Discolouration and odour problems caused by the biological consequences of more intense rainfall events **increase drinking water quality risk**	More intense rainfall events	Increased drinking water quality risk	3	3	9		3	3	9		
WTWs	Treatment works	FLOOD	Increased runoff leads to greater sediment levels, which **increases drinking water quality risk**	Increased runoff	Increased drinking water quality risk	3	3	9		3	3	9		

						INITIAL RISK LEVEL				RESIDUAL RISK LEVEL				
ASSET FUNCTION	ASSET LEVEL 3	CLIMATE VARIABLE	DESCRIPTION	PRIMARY IMPACT OF CLIMATE VARIABLE	IMPACT ON SERVICE	Level of Impact	Level of likelihood	Level of risk	COMPANY'S EXISTING ADAPTIVE ACTIONS	Level of Impact	Level of likelihood	Level of risk	COMPANY'S PROPOSED ACTION TO REDUCE RESIDUAL IMPACTS	Additional note from workshop
WTWs	Service Reservoirs & Water Towers	FLOOD	Direct flooding causes contaminants to enter underground storage tanks **increasing drinking water quality risk**	Direct flooding	Increased drinking water quality risk	3	3	9	Service reservoirs are currently vulnerable - No current adaptation in place. Design vulnerabilities.	3	3	9		similar risks are scored at the workshop. To allow correct calculation - scores are determined post workshop
WTWs	Service Reservoirs & Water Towers	FLOOD	Direct flooding causes contaminants to enter pipelines, **increasing drinking water quality risk**	Direct flooding	Increased drinking water quality risk	2	2	4	Maintenance.	2	1	2		
WTWs	All Water Treatment	GENERAL	Relocation of permanent and tourist population from drought, temperature rise, flooding or sea level rise (impacts D2, T2, T3, T5, F3, S2) changes supply-demand balance. Response chosen (within WR) **impacts WTW requirements and capacity needed.**	Relocation of population from weather, flooding, sea level rise	Impacts WTW requirements and capacity and reduced security of supply	1	1	1		1	1	1		
WTWs	Treatment works	SEA LEVEL	Tidal limits move upstream and lead to greater salinity at intakes, causing **raw water resource loss** and **reduction in security of supply**	Tidal limits moving upstream and increasing salinity at intakes	Reduced security of supply	2	2	4	Pumping regimes.	2	1	2		
WTWs	All Water Treatment	SEA LEVEL	Direct asset flooding, storm damage and coastal erosion or 'planned retreat' cause **service failure and asset loss**	Direct asset flooding, storm damage, coastal erosion or planned retreat	Asset loss and service failure	3	1	3		3	1	3		
WTWs	All Water Treatment	SEA LEVEL	Saline intrusion in groundwater increases structural attack on infrastructure, causing **accelerated asset deterioration.**	Saline intrusion in groundwater	Accelerated asset deterioration	1	1	1		1	1	1		
WTWs	All Water Treatment	SEA LEVEL	Sea level rise increases frequency of power loss, causing **service failure**	Sea level rise	Increased frequency of power loss and service failure	1	1	1		1	1	1		
WTWs	Treatment works	SEA LEVEL	Saline intrusion decreases yield, causing a service loss and **reduction in security of supply**	Saline intrusion	Reduced security of supply	2	2	4	What measures were identified as reducing the risk level?	2	1	2		
WTWs	All Water Treatment	TEMP. RISE	Increased algal growth and risk of microscopic organisms within the water supply system **increases drinking water quality risk**	Higher temperatures	Increased drinking water quality risk	2	3	6	Capital programme.	2	2	4		
WTWs	All Water Treatment	TEMP. RISE	Higher average and peak temperatures affect structures, buildings, H & V, MEICA plant working life, causing **accelerated asset deterioration**	Higher average and peak temperatures	Accelerated asset deterioration	1	1	1		1	1	1		
WTWs	Treatment works	TEMP. RISE	Higher temperatures reduce raw water quality and **increase drinking water quality risk**	Higher temperatures	Increased drinking water quality risk	2	1	2		2	1	2		
WTWs	Treatment works	TEMP. RISE	Higher temperatures impact treatment process **improving treated water quality**	Higher temperatures	Improved drinking water quality	-1	1	-1		-1	1	-1	Opportunity	
WTWs	Treatment works	TEMP. RISE	Increased incidence of disease leads to introduction of additional potable standards, **increasing drinking water quality risk**	More frequent disease increasing drinking water quality risk	Increased drinking water quality risk	1	1	1		1	1	1		
WTWs	Treatment works	TEMP. RISE	Discolouration and odour problems caused by the biological consequences of higher temperatures **increase drinking water quality risk**	Higher temperatures	Increased drinking water quality risk	2	1	2		2	1	2		
WTWs	Service Reservoirs & Water Towers	TEMP. RISE	Increased rate of micro-biological growth increases risk of residual chlorine depletion and contamination of supplies, **increasing drinking water quality risk**	Increased micro-biological growth	Increased drinking water quality risk	2	3	6	Monitoring and sampling.	2	2	4		
WTWs	Service Reservoirs & Water Towers	TEMP. RISE	Greater extremities in wetting and drying cycles lead to greater soil movement, causing pipe systems to move **increasing burst frequency**	More extreme wetting and drying cycles	Increased burst frequency	3	3	9	Monitoring leakage.	3	2	6		
WwTWs	All Wastewater treatment	DROUGHT	Changes in domestic waste disposal patterns lead to changes in dry weather flow pollutants, **affecting treatment process.**	Reduced dry weather flow and change in domestic waste disposal	Affects treatment processes	2	2	4	Impact reduced from 2 ->1 as over the years works will acclimatise to higher bacteria levels in the sewers.	1	2	2	Problem likley to increase with greater re-use of grey water.	
WwTWs	Site Pumping stations	DROUGHT	Lower average and minimum sewage carry flows reduce quality in rivers **reducing environmental water quality**	Lower average and minimum sewage flows	Reduced environmental water quality	2	2	4		2	2	4		similar risks are scored at the workshop. To allow correct calculation - scores are determined post workshop
WwTWs	Site Pumping stations	DROUGHT	Lower average and peak 'carry' flows lead to settlement in the system, affecting pumping regimes and causing **accelerated asset deterioration**	Lower average and peak flows	Accelerated asset deterioration	2	2	4	1. Chemical dosing to reduce H2S levels. 2. Self cleansing pump systems in use	2	2	4	1. Need for more back up pumps as there's lots of pumps in Wales so increased failures would have a very high impact. 2. Use of materials which resist corrosion. 3. Maintain self cleansing systems and design pump stations to resist wear.	
WwTWs	Treatment works	DROUGHT	Lower average and peak 'carry' flows lead to settlement in the system, with shock loads affecting process regimes and **causing accelerated asset deterioration** and **H&S risk**	Lower average and peak flows	Accelerated asset deterioration and H&S risk	2	2	4	1. Some screening handling equipment already has dual speeds to deal with varying flows. 2. Bag it & Bin it campaign already running to raise public awareness of dumping inappropriate items down toilets.	2	2	4	1. These assets have short life spans so lots of opportunity to adapt to changes over the next 25 years. 2. Increase profile of the B&B campaign as it doesn't appear to be working well(This is why level of likelihood remains at level 2). 3. More investment into implementing better operating screens at treatment works	
WwTWs	Treatment works	DROUGHT	Lower average and peak 'carry' flows reduce volumes received at WWTW and **affects process regime**	Lower average and peak flows	Affects process regime	1	2	2	Manual interventions	1	2	2	1. More manual operator intervention necessary to increase flexibility in being able to carry out the treatment process effectively.	
WwTWs	Treatment works	DROUGHT	Lower average and peak 'carry' flows reduce wetting rates onto process requiring minimum HLR (e.g. trickling filters), **increasing need for recirculation pumping**	Lower average and peak flows	Increased need for recirculation pumping	3	3	9	None	3	3	9	Very few plants have comprehensive recirculation systems in place currently. There is a need to address this.	

						INITIAL RISK LEVEL				RESIDUAL RISK LEVEL				
ASSET FUNCTION	ASSET LEVEL 3	CLIMATE VARIABLE	DESCRIPTION	PRIMARY IMPACT OF CLIMATE VARIABLE	IMPACT ON SERVICE	Level of Impact	Level of likelihood	Level of risk	COMPANY'S EXISTING ADAPTIVE ACTIONS	Level of Impact	Level of likelihood	Level of risk	COMPANY'S PROPOSED ACTION TO REDUCE RESIDUAL IMPACTS	Additional note from workshop
WwTWs	Treatment works	DROUGHT	Lower average and peak 'carry' flows increases retention times in settlement tanks leading to **increased septicity / odour problems.**	Lower average and peak flows	Increased septicity / odour problems	3	2	6	1. Lots of plants have duplicate tanks (e.g. 2 trickling filter beds) so some can be taken out of use during low flow. 2. Odour strategy in place to deal with customer complaints but it doesn't account for climate change so level of impact remains level 3).	3	2	6	1. Account for climate change in odour strategy	
WwTWs	Treatment works	DROUGHT	Lower river flows, increased seasonal variability and reduced water quality lead to the tightening of discharge consents, **increasing the risk of a consent failure/pollution incident**	Lower river flows & increased seasonal variability	Reduced water quality, increased risk of a consent failure / pollution incident	3	2	6	No plans in place for the next 25 years but very little deterioration in water quality being observed currently.	3	2	6		
WwTWs	Outfalls	DROUGHT	Lower river flows mean effluent is required to maintain river flows, reducing flexibility and **increasing the risk of a consent failure/pollution incident**	Lower river flows	Reducing flexibility and increased risk of a consent failure / pollution incident	2	2	4	None	2	2	4	Ofwat will have to approve increased spend to enable DCWW to meet lowering consents	
WwTWs	All Wastewater treatment	FLOOD	Direct asset flooding causes **service failure and asset loss**	Direct asset flooding	Asset loss and service failure	3	3	9		3	3	9	Nothing. Vital that this is looked at urgently.	
WwTWs	All Wastewater treatment	FLOOD	Increased storm frequency and power supply flooding increases frequency of power loss, causing **service failure**	More frequent storms and power supply flooding	Power outages and service failure	2	3	6	None	2	3	6	1. As some transformers are run by DCWW and some by power companies more transparency on who is responsible for what is necessary. Also more co-operation is needed in dealing with these problems and risks. 2. Lobby Defra and power companies to deal with these issues where appropriate.	
WwTWs	All Wastewater treatment	FLOOD	Increased duration at FFT causes difficulties with managing performance **increasing risk of consent failure.**	Longer FFT	Increased risk of consent failure	3	3	9		3	3	9	More analysis of the effects on treatment works serviceability . This will highlight the ones losing headroom.	
WwTWs	Site Pumping stations	FLOOD	Increased volumes of storm water require increased pumping in combined sewer systems, causing **accelerated asset deterioration**	Increased volumes of storm water in combined sewers	Increased pump usage & accelerated asset deterioration	1	2	2	1. Surface Water Management Strategy (SWMS)/Surface Water Elimination and Reduction (SWEAR) should be covering this. 2. MEICA assets have short life, so some adaptation in the AMP cycle.	1	1	1		
WwTWs	Treatment works	FLOOD	Extended duration of FFT at WwTW due to duration and storage return affects process regime and causes **accelerated asset deterioration** and **asset failure**	Longer FFT at WwTW	Accelerated asset deterioration and failure	1	2	2	SWMS is aimed at reducing flows to treatment works	1	1	1		
WwTWs	Treatment works	FLOOD	Increased intensity rainfall events and higher average flows cause hydraulic overload of treatment process, causing **service loss**	More intense rainfall and higher average flows	Service failure	3	3	9	1. SWMS is looking into reducing surface water in storm events. 2. Correct inlet controls mean that higher rainfall won't affect hydraulic overload but many plants won't have these controls	2	3	6		
WwTWs	Treatment works	FLOOD	Dilution of, and rapid variations in, influent flows **affects process performance efficiency**	More dilution / variability in influent flows	Reduction in process performance efficiency	2	2	4	SWEAR should reduce extreme high flow incidents	2	2	4	Needs to be incorporated/coordinated with Automation Strategy: Better remote monitoring to be more aware of what's happening to help deal more effectively with such problems. (i.e. possibly introducing 24 hour monitoring). This is most urgent at AS plants as they are most vulnerable to these variations.	
WwTWs	Treatment works	FLOOD	Increased flushing effect (from sewer or PST washout) leads to higher loads to be treated, **affecting process performance efficiency** and causing **service failure**	Increased flushing effect (from sewer or PST washout)	Reduction in process performance efficiency leading to service failure	3	3	9	1. It's happening now and will get worse so level of impact is currently a 3. However, SWEAR is looking into ways of removing surface water so it could become a level 2 impact in the future.	2	3	6	Assets standards and specs to deal with these changes over the next 25 years must be built into the next set of reviews.	
WwTWs	Treatment works	FLOOD	Longer retention of water in storm tanks leads to increased septicity and operational problems, **affecting process performance efficiency** and **increased odour**	Longer retention of water in storm tanks	Reduction in process performance efficiency leading to odour problems	2	3	6	SWEAR strategy, and some UV treatment of storm water has been put in place but only in bathing water areas.	2	3	6		
WwTWs	Outfalls	FLOOD	Higher peak levels at the discharge change outfall hydraulics and back up pumps, causing **service failure**	Higher peak levels at discharges	Service failure	2	3	6	Can claim fluvial flooding in order to avoid failing our consents. Nothing being done	2	3	6		
WwTWs	All Wastewater treatment	GENERAL	Relocation of permanent and tourist population from drought, temperature rise, flooding or sea level rise (impacts D2, T2, T3, T5, F3, S2) changes supply-demand balance. Response chosen (within WR) **impacts wastewater treatment requirements and capacity needed.**	Relocation of population from weather, flooding, sea level rise	Impacts wastewater treatment requirements and capacity needed	1	1	1	Not in issue over the next 25 years	1	1	1		
WwTWs	All Wastewater treatment	SEA LEVEL	Direct asset flooding, storm damage and coastal erosion cause **service failure** and **asset loss**	Direct asset flooding, storm damage, coastal erosion or planned retreat	Asset loss and service failure	3	2	6	No strategy in place.	3	2	6	Long life assets so much care needs to be taken when planning	
WwTWs	All Wastewater treatment	SEA LEVEL	Saline intrusion degrades infrastructure, causing **accelerated asset deterioration**	Saline intrusion	Accelerated asset deterioration	2	2	4	Nothing is being done but a 10-15cm rise over 25 years is not seen as a significant problem. Also, a lot of the problems already experienced have been due to deterioration (poor maintenance) of networks.	2	2	4	Not a huge amount of service will be lost over the next 25 years but more investment is needed to address existing levels of intrusion. No additional solutions proposed.	
WwTWs	Site Pumping stations	SEA LEVEL	Higher receiving water levels leads to increased pumping requirement , **causing accelerated asset deterioration**	Higher receiving water levels	Increased asset use and accelerated asset deterioration	1	1	1		1	1	1	Make sure manhole covers etc. Are fully operational	
WwTWs	Treatment works	SEA LEVEL	Saline intrusion increases sewage salinity which impacts on H2S formation, reduces primary and FST sludge settleability, reduces dewaterability of SAS. Potential impact on ASP microbiology due to rate of salinity change, dissolved oxygen saturation causing **accelerated asset deterioration** and **reduced process performance**	Saline intrusion	Accelerated asset deterioration and reduced process performance	2	1	2	No additional saline intrusion has been noted yet.	2	1	2		

						INITIAL RISK LEVEL				RESIDUAL RISK LEVEL				
ASSET FUNCTION	ASSET LEVEL 3	CLIMATE VARIABLE	DESCRIPTION	PRIMARY IMPACT OF CLIMATE VARIABLE	IMPACT ON SERVICE	Level of Impact	Level of likelihood	Level of risk	COMPANY'S EXISTING ADAPTIVE ACTIONS	Level of Impact	Level of likelihood	Level of risk	COMPANY'S PROPOSED ACTION TO REDUCE RESIDUAL IMPACTS	Additional note from workshop
WwTWs	Outfalls	SEA LEVEL	Higher peak levels at the discharge change outfall hydraulics and back up pumps causing **service failure**	Higher peak levels at discharges	Service failure	1	1	1		1	1	1		
WwTWs	Outfalls	SEA LEVEL	Higher sea levels affect dispersion characteristics, leading to **different classification, tightened consent, & H+S risk.**	Higher sea levels	Different classification, tightened consent and H&S risk	1	1	1		1	1	1		
WwTWs	All Wastewater treatment	TEMP. RISE	Higher average and peak temperatures affect structures, buildings, H & V, MEICA plant working life, **causing accelerated asset deterioration**	Higher average and peak temperatures	Accelerated asset deterioration	2	3	6	None	2	3	6	Asset Standards and Specifications Specify that new equipment must be able to operate under higher temperatures .	
WwTWs	All Wastewater treatment	TEMP. RISE	Higher temperatures lead to greater microbial action, and increased gas production and risk of ignition **endangers H&S of site staff**	Higher temperatures	Increased H&S risk	3	2	6	No strategy in place.	3	2	6	Get DSEAR to look into this	
WwTWs	All Wastewater treatment	TEMP. RISE	Higher levels of UV decrease microbe propagation & survivability, **affecting treatment process**	Higher levels of UV	Treatment process effects	1	1	1	Not an issue	1	1	1		
WwTWs	All Wastewater treatment	TEMP. RISE	Higher temperatures and septicity levels reduce works performance, **increasing the risk of a consent failure**	Higher temperatures	Reduction in treatment process performance and increased risk of consent failure	1	2	2	Low Impact	1	2	2		
WwTWs	All Wastewater treatment	TEMP. RISE	Higher temperatures lead to increased amenity use (e.g. bathing waters) leading to **tightened consent** and/or **increased H&S risk** near discharge points	Higher temperatures	Tighter consents and/or increased H&S risk near discharge points	2	2	4	No strategy in place	2	2	4		
WwTWs	Site Pumping stations	TEMP. RISE	Increased levels of septicity affect pumping regimes and cause **accelerated asset deterioration** and **increased odour**	Greater septicity affecting pumping regimes	Accelerated asset deterioration and increased odour	1	2	2		1	2	2		
WwTWs	Treatment works	TEMP. RISE	Increased levels of septicity in received sewage causes **increased odour**	Greater septicity in received sewage	Increased odour	2	2	4	There is an odour strategy already in place but it is reactive not proactive	2	2	4	The odour strategy must be more proactive and focus more on climate change	
WwTWs	Treatment works	TEMP. RISE	Effluent standards raised to meet temperature-affected Water Quality Objectives [O2 etc], **increasing the risk of a consent failure/pollution incident**	Effluent standards raised to meet temperature-affected Water Quality Objectives	Increased risk of consent failure/pollution incident	2	3	6	No current plans for the future	2	3	6		
WwTWs	Treatment works	TEMP. RISE	Higher rate of biological activity causes **change to process efficiency**	Higher rate of biological activity	Change to process efficiency	-1	2	-2	This is potentially positive	-1	2	-2	Opportunity	
WwTWs	Treatment works	TEMP. RISE	Lower summer flows and reduced freezing frequency lead to increased insect issues and create an **environmental health risk**	Lower summer flows and reduced freezing frequency	Increased environmental health risk	2	2	4	Dosing already in place to deal with this as are nets to control insects	2	2	4	Important this is dealt with appropriately as there is potential for £20,000/day fines.	
WwTWs	Treatment works	TEMP. RISE	Fewer months below critical process temperatures causes **increase process efficiency**	Fewer months below critical process temperatures	Increased process efficiency	-1	2	-2	This is potentially positive	-1	2	-2	Opportunity	
WwTWs	Treatment works	TEMP. RISE	Increased septicity levels and odour chemicals lead to **increased health risk**	Greater septicity and (use of?) odour chemicals	Increased health risks	2	2	4		2	2	4	Reflect in H&S Standards and COSHH assessments, and chemical storage needs.	
WwTWs	Treatment works	TEMP. RISE	Increased septicity levels promote growth of undesirable species and inhibit growth of normal aerobic heterotrophs, **affecting process performance efficiency**	Greater septicity	Reduction in process performance efficiency	2	2	4	Selector zones (which select the right microorganisms to develop in digesters in order for the AS process to occur effectively) are already in spec. The level of impact is reduced as a result.	1	2	2	Smarter specification to take account of CC impacts	
WwTWs	Treatment works	TEMP. RISE	Increased septicity in sewers / primary tanks leads to poor primary settlement and increased load onto secondary process **affecting process performance efficiency**	Greater septicity in sewers / primary tanks	Reduction in process performance efficiency	2	2	4		1	2	2	Not a big risk but there is a need to increase process flexibility and design moving forward to deal with this.	
WwTWs	Treatment works	TEMP. RISE	Increased temperatures lead to lower oxygen transfer efficiency in secondary process, **affecting process performance efficiency**	Increased temperatures	Reduction in process performance efficiency	2	3	6		2	3	6	There is a need for increased retention Oxygen transfer: specs for better diffusers	
WwTWs	Outfalls	TEMP. RISE	Increased levels of septicity lead to increased toxicity, **reducing receiving water quality** and **increasing odour**	Greater septicity	Reduced receiving water quality and increased odour	2	2	4		2	2	4	Group thinks that SWEAR may have an adverse impcat on this.	
WwTWs	Outfalls	TEMP. RISE	Reduced oxygen saturation as water temperature increases, **increasing the risk of a consent failure/pollution incident**	Warmer water leading to reduced oxygen saturation	Increased risk of consent failure/pollution incident	3	3	9	This is a big problem which is getting worse with no forward plans	3	3	9		
Sludge	All Sludge	DROUGHT	Change in domestic waste disposal patterns leads to change in dry weather flow pollutants **affecting composition of sludge**	Change in domestic waste disposal	Changed composition of sludge	1	1	1	Not a problem	1	1	1		
Sludge	Sludge treatment	DROUGHT	Increase in the generation of dust causes **accelerated asset deterioration** and **endangers H&S of site staff**	More dust	Accelerated asset deterioration and impacts on H&S	1	1	1	Not an issue as intent is for dryers to be shut down/phased out	1	1	1		
Sludge	Sludge disposal or re-cycling	DROUGHT	Agricultural practice change affects sludge demand and **affects agricultural demand for sludge**	Agricultural practice change	Changes in agricultural demand for sludge	2	1	2	Not a huge problem	2	1	2		
Sludge	Sludge disposal or re-cycling	DROUGHT	Lower water flow increases concentration of toxic compounds in sludge, affecting sludge reuse and/or incineration and leading to **waste disposal issues**	Lower water flow	Increased concentration of toxic compounds in sludge affecting reuse and/or incineration	1	1	1	Not a problem	1	1	1		
Sludge	All Sludge	FLOOD	Direct asset flooding causes **service failure and asset loss**	Direct asset flooding	Asset loss and service failure	3	1	3	Larger sludge treatment plants are unlikely to flood due to their topography.	3	1	3	Many WTW's have already had flood risk assessments carried out on them compared to the relatively few assessments performed on WwTW's.	

						INITIAL RISK LEVEL				RESIDUAL RISK LEVEL				
ASSET FUNCTION	ASSET LEVEL 3	CLIMATE VARIABLE	DESCRIPTION	PRIMARY IMPACT OF CLIMATE VARIABLE	IMPACT ON SERVICE	Level of Impact	Level of likelihood	Level of risk	COMPANY'S EXISTING ADAPTIVE ACTIONS	Level of Impact	Level of likelihood	Level of risk	COMPANY'S PROPOSED ACTION TO REDUCE RESIDUAL IMPACTS	Additional note from workshop
Sludge	All Sludge	FLOOD	Increased storm frequency increases frequency of power loss, causing **service failure**	More frequent storms and power supply flooding	Power outages and service failure	2	3	6	None	2	3	6	1. As some transformers are run by DCWW and some by power companies more transparency on who is responsible for what is necessary. Also more co-operation is needed in dealing with these problems and risks. 2. Lobby Defra and power companies to deal with these issues where appropriate.	
Sludge	Sludge disposal or re-cycling	FLOOD	Flooding prevents access to fields causing **service failure**	Flooding prevents access to fields	Service failure	3	3	9		3	3	9		
Sludge	Sludge disposal or re-cycling	FLOOD	Flooding cuts sludge transport routes causing **service failure**	Flooding of sludge transport routes	Service failure	1	1	1		1	1	1		
Sludge	Sludge disposal or re-cycling	FLOOD	Increased run off rates from sludge treated agricultural land **reduce receiving water quality**	Increased runoff from sludge-treated agricultural land	Reduced receiving water quality	2	2	4	None	2	2	4	Develop diffuse pollution measures	
Sludge	All Sludge	GENERAL	Relocation of permanent and tourist population from drought, temperature rise, flooding or sea level rise (impacts D2, T2, T3, T5, F3, S2) changes supply-demand balance. Response chosen (within WR) **impacts sludge treatment, storage and disposal requirements and capacity needed.**	Relocation of population from weather, flooding, sea level rise	Impacts sludge treatment, storage and disposal requirements and capacity needed	1	1	1		1	1	1		
Sludge	All Sludge	SEA LEVEL	Direct asset flooding, storm damage and coastal erosion cause **service failure** and **asset loss**	Direct asset flooding, storm damage, coastal erosion or planned retreat	Asset loss and service failure	2	2	4	None	2	2	4		
Sludge	All Sludge	SEA LEVEL	Saline intrusion degrades infrastructure, causing **accelerated asset deterioration**	Saline intrusion	Accelerated asset deterioration	2	2	4		2	2	4		
Sludge	All Sludge	TEMP. RISE	Higher average and peak temperatures cause an **increase in incidence of sludge related disease**	Higher average and peak temperatures	Increase in incidence of sludge related disease	1	1	1	Not anticipated	1	1	1		
Sludge	All Sludge	TEMP. RISE	Higher average and peak temperatures affect structures, buildings, H & V, MEICA plant working life, causing **accelerated asset deterioration**	Higher average and peak temperatures	Accelerated deterioration of assets	1	1	1		1	1	1		
Sludge	Sludge treatment	TEMP. RISE	Higher average temperatures reduce heating requirement for sludge digestion and **affects performance**	Higher average temperatures	Reduced heating requirement for sludge digestion	-1	1	-1		-1	1	-1	Opportunity	
Sludge	Sludge disposal or re-cycling	TEMP. RISE	Agricultural practice change **affects agricultural demand for sludge**	Agricultural practice change	Change in agricultural demand for sludge	3	1	3		3	1	3		
Sludge	Sludge disposal or re-cycling	TEMP. RISE	Higher temperatures lead to greater microbial action, and increased gas production and risk of ignition in storage **endangers H&S of site staff**	Higher temperatures	Increased H&S risks	1	1	1	DSEAR already in place to deal with this	1	1	1		
Sludge	Sludge disposal or re-cycling	TEMP. RISE	Higher temperatures lead to increased insect issues and create an **environmental health risk**	Higher temperatures	Increased insect problems	1	1	1		1	1	1		
WW networks	Sewer networks, incl./trunk sewers	DROUGHT	Lower precipitation, infiltration & inflow and water conservation lead to lower average and peak 'carry' flows, resulting in greater sewer deposits and more frequent blockages, causing **customer flooding**	Lower precipitation, infiltration & inflow plus water conservation	More frequent sewer blockages and increased customer flooding	3	2	6	Modelling and DAPs identify critical assets. Hawkeye investment	3	2	6	For drought conditions, Improved modelling of low flows.	Only 5% of blockages cause flooding, but if it does cause flooding, then it would be a level 3 impact. However, the likelihood of is causing flooding is currently low, but may increase, therefore level 2 likelihood.
WW networks	Pumping stations	DROUGHT	Lower average and peak 'carry' flows lead to settlement in the system, affecting pumping regimes and causing **accelerated asset deterioration**	Lower average and peak flows	Accelerated asset deterioration	1	1	1		1	1	1		Unsure if this does cause accelerated asset deterioration from droughts as there will always be a flushing flow. In the North, cleaning hasn't been done regularly in previous years, but starting to improve now. Grit is already in the system, so any grit in the system will get in to the pump station eventually, inevitably, whether it is brought in in one go or over a longer period of time.
WW networks	Rising mains	DROUGHT	Lower average and peak 'carry' flows lead to H2S settlement in the system, causing **accelerated asset deterioration**	Lower average and peak flows	Accelerated asset deterioration	2	3	6		2	3	6	Accelerate asset replacement . Analysis of mode failure to identify areas of increasing concern and research requirements.	Odour issues, and very aggressive in treatment works. Collapses are happening now in the system, attributable to H2S.
WW networks	CSOs and overflows	DROUGHT	Lower average and peak 'carry' flows lead to settlement in the system, with shock loads causing CSO **H&S risk** and **reduced receiving water quality**	Lower average and peak flows	Reduced receiving water quality and CSO H&S risk	3	1	3		3	1	3		What H&S risks? If someone is daft enough to be in a CSO, then impact is high, but due to DCWW procedures, the likelihood of that occurring is very low.
WW networks	All wastewater networks	FLOOD	Direct asset flooding causes **service failure and asset loss**	Direct asset flooding	Asset loss and service failure	3	2	6		3	2	6	Determine flood resilience of network, as has been done for the clean water assets. Ensure predicted increases in flooding are considered in the design of new assets or when replacing flood susceptible assets such as telemetry, replace with floods in mind (electricity higher off the ground, safe access during floods etc.) Implement SWRS and mainstream the use of SUDS. Establish quantitative thresholds for flood defence to determine acceptability of risk. Influence decision makers to reduce trend towards urban creep.	Threshold issue, and so depends on level of change. Not huge number's of assets at risk (NEED TO CHECK IF THIS WORK HAS REALLY BEEN COMPLETED).
WW networks	All wastewater networks	FLOOD	Increased storm frequency increases frequency of power loss, causing **service failure**	More frequent storms and power supply flooding	Power outages and service failure	3	2	6	Critical assets have back-up generators and major assets have dual electricity supply from a separate sub-station. Consideration of power outage is included in design of assets, ensuring overflows will not lead to customer flooding.	3	2	6	Critical sweep of assets. Ensure back up generators are maintained and not lost during cost cutting exercises.	Don't know likelihood of impact on other people's assets.

						INITIAL RISK LEVEL				RESIDUAL RISK LEVEL				
ASSET FUNCTION	ASSET LEVEL 3	CLIMATE VARIABLE	DESCRIPTION	PRIMARY IMPACT OF CLIMATE VARIABLE	IMPACT ON SERVICE	Level of Impact	Level of likelihood	Level of risk	COMPANY'S EXISTING ADAPTIVE ACTIONS	Level of Impact	Level of likelihood	Level of risk	COMPANY'S PROPOSED ACTION TO REDUCE RESIDUAL IMPACTS	Additional note from workshop
WW networks	Sewer networks, incl./trunk sewers	FLOOD	Higher rainfall intensities lead to runoff exceeding combined sewer capacity, causing **surface flooding** and **reducing receiving water quality**	Higher rainfall intensities	Surface flooding and reduced receiving water quality	3	3	9	SWRS and Pollution Strategy. Increased allocation of money to drainage and DAPs in AMP5.	3	2	6	More monitoring of flows to quantify risks. Implement SWRS and mainstream the use of SUDS. Influence decision makers to reduce trend towards urban creep. Build flexibility in to the initial design, to allow for climate changes to influence	V. high impact
WW networks	Sewer networks, incl./trunk sewers	FLOOD	Increased volumes of storm water in combined sewers exceeds sewer capacity and causes **customer flooding**	Increased volumes of storm water	Customer flooding	3	3	9	SWRS to reduce the water entering the sewers. Adoption of private sewers will lead to greater understanding of risks.	3	2	6	Implement SWRS and mainstream the use of SUDS. Influence decision makers to reduce trend towards urban creep.	V. high impact
WW networks	Sewer networks, incl./trunk sewers	FLOOD	Higher groundwater levels cause increased infiltration into sewers, causing **customer flooding**	Higher groundwater levels	Customer flooding	3	2	6		3	2	6	More resilient design guidance where required to reduce infiltration in prone areas Ensure design standards consider as many cliamte change risks as possible. To determine increases in infiltration, more monitoring of flows required. Partnership working, both internally and externally, to identify trends in the data, and use mapping to identify clusters and therefore allow for more strategic changes. Implement SWRS and mainstream the use of SUDS to leave capacity in the system for other changes.	Wetter winters over 2-3 years can increase the groundwater levels.
WW networks	Sewer networks, incl./trunk sewers	FLOOD	Change in customer behaviour lead to increased instances of sewer misuse (dumping down sewer) leading to blockages which cause **sewer flooding** and **reduce environmental water quality**	Increased sewer misuse	Blockages, sewer flooding and reduced environmental water quality	1	1	1	Educational works, and adoption of private sewers	1	1	1		Not linked to climate change
WW networks	Pumping stations	FLOOD	Increased volumes of storm water exceed pump capacity, causing **service failure** and **impacting on receiving water quality** at outfall	Increased volumes of storm water	Service failure and reduced receiving water quality	3	2	6	SWRS and SUDS	3	2	6	Determine flood resilience of network, as has been done for the clean water assets. Implement SWRS and mainstream the use of SUDS to reduce the costs of pumping and the risk of PSs reaching their capacity.	There is good redundancy in PSs to avoid customer flooding, as water will go to an overflow prior to flooding properties.
WW networks	Pumping stations	FLOOD	Increased volumes of storm water require increased pumping in combined sewer systems, causing **accelerated asset deterioration**	Increased volumes of storm water in combined sewers	Increased pump usage & accelerated asset deterioration	1	3	3	SWRS and SUDS	1	3	3	Implement SWRS and mainstream the use of SUDS to reduce requirement for pumping. Consider prioritising for critical catchments, identified through workshops with ops teams and other water users. Critical catchments for pumping include Chester.	Increased costs, but can hande that in the system.
WW networks	Rising mains	FLOOD	Increased volumes of storm water exceed raising main capacity, causing burst and subsequent **service failure**	Increased volumes of storm water	Increased bursts and service failure	3	1	3	SWRS and SUDS	3	1	3	Implement SWRS and SUDS. Analysis of mode failure to identify areas of increasing concern and research requirements	Vol. likely to not increase burst and service failure.
WW networks	CSOs and overflows	FLOOD	Higher storm intensity means CSOs spill more frequently, **impacting on receiving water quality**	Higher storm intensity	Increased CSO spill frequency and reduced receiving water quality	2	3	6	SWRS and SUDS	2	3	6	Implement SWRS and SUDS. Influence decision makers to reduce trend towards urban creep.	V uncertain if CSO impacts on reduced W quality.
WW networks	CSOs and overflows	FLOOD	Higher winter flows dilute and reduce the effect of spills, reducing impact of spills and **improving receiving water quality**	Higher winter flows	Improved receiving water quality	-1	1	-1	SWRS and SUDS	-1	1	-1	Opportunity	Can not assume opportunity - v unlikely, minor dilution, but longer spillage.
WW networks	CSOs and overflows	FLOOD	Increased flood incidence **increases risk of failure of 'spills per bathing season' type consents.**	More frequent flooding	Increased risk of failing 'spills per bathing season' consents	3	3	9	SWRS and SUDS	3	2	6	Monitoring rainfall and CSO outflows to forewarn people about risks.	Increased costs, but can hande that in the system.
WW networks	All wastewater networks	GENERAL	Relocation of permanent and tourist population from drought, temperature rise, flooding or sea level rise (impacts D2, T2, T3, T5, F3, S2) changes supply-demand balance. Response chosen (within WR) **impacts wastewater networks requirements and capacity needed.**	Relocation of population from weather, flooding, sea level rise	Impacts wastewater network requirements and capacity and reduced security of supply	1	2	2		1	2	2		Big population changes in Llyn Peninsular, if MORE people moving to Wales from other parts of the world or UK, then great increase, and would affect the impact. No impact of reduced security of supply for sewerage.
WW networks	All wastewater networks	SEA LEVEL	Direct asset flooding, storm damage and coastal erosion or planned retreat cause **service failure** and **asset loss**	Direct asset flooding, storm damage, coastal erosion or planned retreat	Asset loss and service failure	3	2	6		3	2	6	Determine flood resilience of network, as has been done for the clean water assets. Likelihood may be reduced following these studies.	Rhyl has retreat as option and assets on that line. If retreat option causes many people to have to move, then this will definitely affect the service. Needs investigation and discussions with the EA about where they are managing retreat, (although you would imagine that DCWW were consulted on this issue?)
WW networks	All wastewater networks	SEA LEVEL	Saline intrusion degrades infrastructure, causing **accelerated asset deterioration**	Saline intrusion	Accelerated asset deterioration	1	1	1		1	1	1	Analysis of mode failure to identify areas of increasing concern and research requirements	Saline intrusion is difficult to quantify, but it is not going to lead to service loss, it will likely be noticed.
WW networks	Sewer networks, incl./trunk sewers	SEA LEVEL	High rainfall and high tides coinciding causes increased **customer flooding** and **reduce receiving water quality**	High rainfall adding to high tides	Increased customer flooding and reduced receiving water quality	3	3	9	Sea defences built to 1:200 yr event, SWRS.	3	3	9	Influence decision makers to reduce trend towards urban creep. Likelihood is unknown, so needs study to understand.	Joint probability - low pressure so link between storm surges and rainfall. We have a lot of tidal systems where we pump, such as whole of Chester is drained by pumping in tidal locked system.
WW networks	Sewer networks, incl./trunk sewers	SEA LEVEL	Saline intrusion and subsequent H2S formation in sewer creates **environmental health risk**	Saline intrusion	Environmental health risk	1	1	1		1	1	1		Unlikely
WW networks	Sewer networks, incl./trunk sewers	SEA LEVEL	Saline intrusion increases corrosion, leading to **accelerated asset deterioration**	Saline intrusion	Accelerated asset deterioration	1	1	1		1	1	1	Analysis of mode failure to identify areas of increasing concern and research requirements	Sewage is already aggressive so saline is no more aggressive than that.
WW networks	CSOs and overflows	SEA LEVEL	Costal esturine CSO discharges become tide-locked, hindering free discharge and causing **customer flooding** and **reducing received water quality**	Tide locked intermittent discharges	Customer flooding and reduced receiving water quality	3	3	9	SWRS to reduce the water entering the sewers and leave capacity for storage.	3	3	9		This is probably not going to happen anymore, as there has been a lot of investment in reducing the areas where properties are flooded by sewage. However, in catchments that have lots of tide locked systems, the likelihood may be quite high.
WW networks	CSOs and overflows	SEA LEVEL	High rainfall and high tides coincide and affect CSO discharges, **reducing receiving water quality**	High rainfall adding to high tides	reducing receiving water quality	2	3	6	SWRS and SUDS	2	3	6		Backwater effect from overflow being tide locked and spillage from upstream on CSOs
WW networks	All wastewater networks	TEMP. RISE	Higher average and peak temperatures affect structures, buildings, H & V, MEICA plant working life, **causing accelerated asset deterioration**	Higher average and peak temperatures	Accelerated asset deterioration	1	1	1		1	1	1	Analysis of mode failure to identify areas of increasing concern and research requirements	If significant temperature increase in peak ambient temperature then would affect it. Currently, designed for 35 degrees C. Didn't have any failures during the last heat wave. Telemetry failure calls out for service and is quickly responded to. Just increased fans.

						INITIAL RISK LEVEL				RESIDUAL RISK LEVEL				
ASSET FUNCTION	ASSET LEVEL 3	CLIMATE VARIABLE	DESCRIPTION	PRIMARY IMPACT OF CLIMATE VARIABLE	IMPACT ON SERVICE	Level of Impact	Level of likelihood	Level of risk	COMPANY'S EXISTING ADAPTIVE ACTIONS	Level of Impact	Level of likelihood	Level of risk	COMPANY'S PROPOSED ACTION TO REDUCE RESIDUAL IMPACTS	Additional note from workshop
WW networks	All wastewater networks	TEMP. RISE	Higher temperatures lead to greater microbial action, and increased gas production and risk of ignition **endangers H&S of site staff**	Higher temperatures	Increased H&S risks	3	1	3	Design of pumping stations includes risks of explosion due to inappropriate use of sewers, so they should be very low likelihood that an explosion would occur or injure a personnel member.	3	1	3		If something did happen, then would be high impact, but already spent a bit of money on protecting against people putting flammable materials down the system, so designed against this.
WW networks	Sewer networks, incl./trunk sewers	TEMP. RISE	Greater extremities in wetting and drying cycles lead to greater soil movement, causing pipe systems to move, leading to **accelerated asset deterioration** and **customer flooding**	More extreme wetting and drying cycles	Accelerated asset deterioration and customer flooding	2	3	6		2	3	6	Analysis of mode failure to identify areas of increasing concern and research requirements	There is already evidence of soil movement leading to collapses, so this is likely to increase. It is 6, as collapses are unlikely to cause flooding to lots of people.
WW networks	Sewer networks, incl.trunk sewers	TEMP. RISE	Increased levels of septicity cause **accelerated asset deterioration** and **increased odour**	Greater septicity	Accelerated asset deterioration and increased odour	2	3	6		2	3	6	Research into environmental control systems to replace existing odour management issues in networks, to reduce reliance on chemicals and reduce energy requirements.Analysis of mode failure to identify areas of increasing concern and research requirements	
WW networks	Pumping stations	TEMP. RISE	Increased levels of septicity affect pumping regimes and causes **accelerated asset deterioration** and **increased odour**	Greater septicity affecting pumping regimes	Accelerated asset deterioration and increased odour	2	3	6		2	3	6	Research into environmental control systems to replace existing odour management issues in networks, to reduce reliance on chemicals and reduce energy requirements.	Drought and temp rise are related. The odour is caused by low flow, as temperature may speed up the rate of biological breakdown, and odour production, but it wouldn't be there without the low flow.
WW networks	Rising mains	TEMP. RISE	Greater extremities in wetting and drying cycles lead to greater soil movement, causing pipe systems to move, leading to **accelerated asset deterioration** and **customer flooding**	More extreme wetting and drying cycles	Accelerated asset deterioration and customer flooding	3	2	6		3	2	6	Improve design guidelines to improve resilience of pipes to soil movement. Analysis of mode failure to identify areas of increasing concern and research requirements	Same as aa reasons, more pollution impact.
WW networks	Rising mains	TEMP. RISE	Increased levels of septicity cause **accelerated asset deteriorati**on and **increased odour**	Greater septicity	Accelerated asset deterioration and increased odour	2	3	6		2	3	6	Research into environmental control systems to replace existing odour management issues in networks, to reduce reliance on chemicals and reduce energy requirements.Analysis of mode failure to identify areas of increasing concern and research requirements	
WW networks	CSOs and overflows	TEMP. RISE	Increased levels of septicity lead to increased toxicity, **reduced receiving water quality** and **increased odour**	Greater septicity	Increased toxicity & odour and lower receiving water quality	1	2	2		1	2	2	Research into environmental control systems to replace existing odour management issues in networks, to reduce reliance on chemicals and reduce energy requirements.	
Non asset based	TRANSPORT	FLOODING	Regional flooding	Unable to get fleet to site	Could loose a site on the back of a serious flood. Some sites with investment will run for 5 weeks without intervention needed.	2	3	6	Maximise remote operations opportunities. Remote management of sites. Changing the transport vehicles (more 4x4). Review local site access for flood risk (build out solution)	2	2	4		
Non asset based	TRANSPORT	FREEZE	Non-localised - regional	Unable to move fleet to site		3	3	9	Actions as above plus priority road salting / strategic salt. . Automation needs to be cold-weather proof. Freeze protection of vehicles. Winterised IT kit. Maximise remote operations opportunities. Remote management of sites. Changing the transport vehicles (more 4x4). Review local site access for flood risk (build out solution)	2	3	6		
Non asset based	TRANSPORT	FREEZE	Non-localised - regional	Office staff cannot get to work	Loss of manpower	2	3	6	Availability of home working - supporting HR and H&S policy. Skills mapping for flexability + disaster recovery plan	1	3	3		
Non asset based	DATA AND COMMS	HEAT	Data centre overheating		Loss of supporting infrastructure. Availability cannot meet demand.	3	3	9	Watercooling (heat exchange) hot water for free (sustainable) Offshoring data. Innovation. Distributed strategy. **FLOOD RISK ASSESSMENT ON DATA CENTRES.** Risk could reduce to 1x1 depending on the number of actions undertaken	2	2	4		
Non asset based	3RD PARTY		WPD (power) NETWORKS / SCOTTISH POWER	Loss of power = loss of service	BUSINESS CRITICAL! Loss of comms / loss of manpower (esp. People working from home). Asset failure.	3	3	9	Reduce energy usage - reduce loading on system. Review emergency generation. Generate more energy (renewables) - Consider how we could advise the customers during power loss / non potable etc	3	3	9		
Non asset based	3RD PARTY		VODAFONE / VIRGIN / SATELLITE		short term issue. Unable to respond to alarms.	3	3	9	Level 7 alarms are generated in event of loss of comms. EP measures in place. Communication through radio. Loud hailer	2	2	4		
Non asset based	3RD PARTY		CHEM SUPPLIERS		Must have chemicals for treatment works. CHLORINE	3	3	9	Boil notice	1	1	1		
Non asset based	3RD PARTY		CHEM SUPPLIERS		Must have chemicals for treatment works. COAGULATION	3	3	9	Do not use notice. EP kicks in.	1	1	1		
Non asset based	3RD PARTY		LANDBANK (loss of through storm or flood)		SLOW! Can survive for 6 months.	2	3	6	The removal of driers has REDUCED adaptive capacity. Mothball driers as backup. Reduce level of treatment.	1	3	3		
Non asset based	3RD PARTY		MATERIALS		Initially low issue - slow burner. Becomes more critical as time goes on.	2	3	6	Supply chain management. Strategic spares stockpile. 'Just in time' supply risk. Mutual aid.	1	3	3		
Non asset based	STAFF		EXTREME WEATHER EVENT - frontline		Impact on people to provide the service. Initially can deal but can rapidly escalate .	2	3	6	Business contingency plans. Skills and training review. Expand strategy across company. Reallocating and redeploying hardware and kit (and staff skills)	1	3	3		
Non asset based	STAFF		EXTREME WEATHER EVENT - support		Impact on people to provide the service. Initially can deal but can rapidly escalate .	2	3	6	Business contingency plans. Skills and training review. Skill mapping. Expand strategy across company. Reallocating and redeploying hardware and kit (and staff skills)	1	3	3		
Non asset based	STAFF	TEMP RISE	Long term temperature increase.		Adaptaive capacity of HR and H&S (People wearing PPE and getting heatstrock. Too warm to wear PPE). Trending change.	1	1	1	Redesign PPE. Training. Working hours (split shift) - working patterns (siestas / night work) - learn from overseas. Supporting policies HR and H&S.	1	1	1		
Non asset based	WATER AS A RESOURCE		COMPETITION FOR RESOURCE - ENGLAND AND ENV		REDUCTION OF SUPPLY FOR WALES AS MORE IS SOLD FOR PROFIT TO WATER DEFICIT AREAS	-3	3	-9		-3	3	-9	Opportunity	

						INITIAL RISK LEVEL				RESIDUAL RISK LEVEL				
ASSET FUNCTION	ASSET LEVEL 3	CLIMATE VARIABLE	DESCRIPTION	PRIMARY IMPACT OF CLIMATE VARIABLE	IMPACT ON SERVICE	Level of Impact	Level of likelihood	Level of risk	COMPANY'S EXISTING ADAPTIVE ACTIONS	Level of Impact	Level of likelihood	Level of risk	COMPANY'S PROPOSED ACTION TO REDUCE RESIDUAL IMPACTS	Additional note from workshop
Non asset based	TRANSPORT	FLOODING	Regional flooding	Staff cannot get to work	Impact on DCWW - impact on other organisations. VPN could not handle loading	3	1	3		3	1	3		
Non asset based	TRANSPORT	TEMP. RISE	Heatwave	Cooling system fails	Delays. Loss of service	1	1	1		1	1	1		
Non asset based	3RD PARTY		GAS / LPG		does not stop delivery of service to customers	3	1	3		3	1	3		
Non asset based	3RD PARTY		MUTUAL AID		None available - we manage	3	1	3		3	1	3		
Non asset based	3RD PARTY		PUBLIC TRANSPORT		Staff cannot reach site	3	1	3		3	1	3		
Non asset based	3RD PARTY		Ristrictions put upon us by others	Compliance and regulations - our place in other supply chains		3	1	3		3	1	3		
Non asset based	STAFF		DISEASE / ILLNESS - frontline	general point* if anything else fails we require more people to deal with it	Increased reliance on manpower and therefore transport / IT etc. Causes periods of intense work activity. Do have a plan (swine flu plan)	2	1	2		2	1	2		
Non asset based	STAFF		DISEASE / ILLNESS - support		Increased reliance on manpower and therefore transport / IT etc. Causes periods of intense work activity. Do have a plan (swine flu plan)	2	1	2		2	1	2		
Non asset based	PEOPLE (population movement)		DEMOGRAPHIC MOVEMENT		increased demand. Slow event, might not be noticed until issues arise. Needs building into long term planning.	2	1	2		2	1	2		
Non asset based	WATER AS A RESOURCE		REGULATORY CONSTRAINTS H&S, STANDARDS FOR SERVICE ETC		Potential to change everything	3	1	3		3	1	3		

Appendix II

Impacts on Water Resource based on UKCP09 Projections

MAX REDUCTION IN DO (%) FROM UKCP09

Zone	Annual Average	Critical Period
Alwen Dee	-1%	-1%
Bala	0%	0%
Barmouth	-14%	-14%
Blaenau Ffestiniog	-7%	-7%
Clwyd Coastal	-6%	-6%
Dyffryn Conwy	0%	0%
Lleyn Harlech	-3%	-3%
M&S Ceredigion	-3%	-3%
Whitbourne	-3%	0%
N Ceredigion	-7%	-7%
NEYM	-37%	-35%
Pembrokeshire	-21%	-21%
South Meirionydd	0%	0%
Tywi Gower	0%	0%
Tywyn Aberdyfi	-16%	-16%
SEWCUS	-6%	-5%
Vowchurch	-5%	0%

IMPACT ON AVAILABLE WATER RESOURCES, KNOWN AS 'DEPLOYABLE OUTPUT' (DO)

For water management purposes, Welsh Water divides its supply area into 24 Water Resource Zones.

The maximum projected impact (i.e. reduction) on DO in 17 Water Resource Zones (WRZ), of Welsh Water's 24 in total, is shown here:

The remaining 7 WRZs were not included in water resource modeling based on assumptions that the main constraints on DO are the abstraction licence conditions and therefore climate change impact is considered currently to be negligible.

The 7 'un-modelled' WRZs are Ross-on-Wye, Elan – Builth, Hereford CUS, Llyswen, Monmouth, Pilleth, and Brecon – Potis.

IMPACT ON SUPPLY DEMAND BALANCE (SDB)

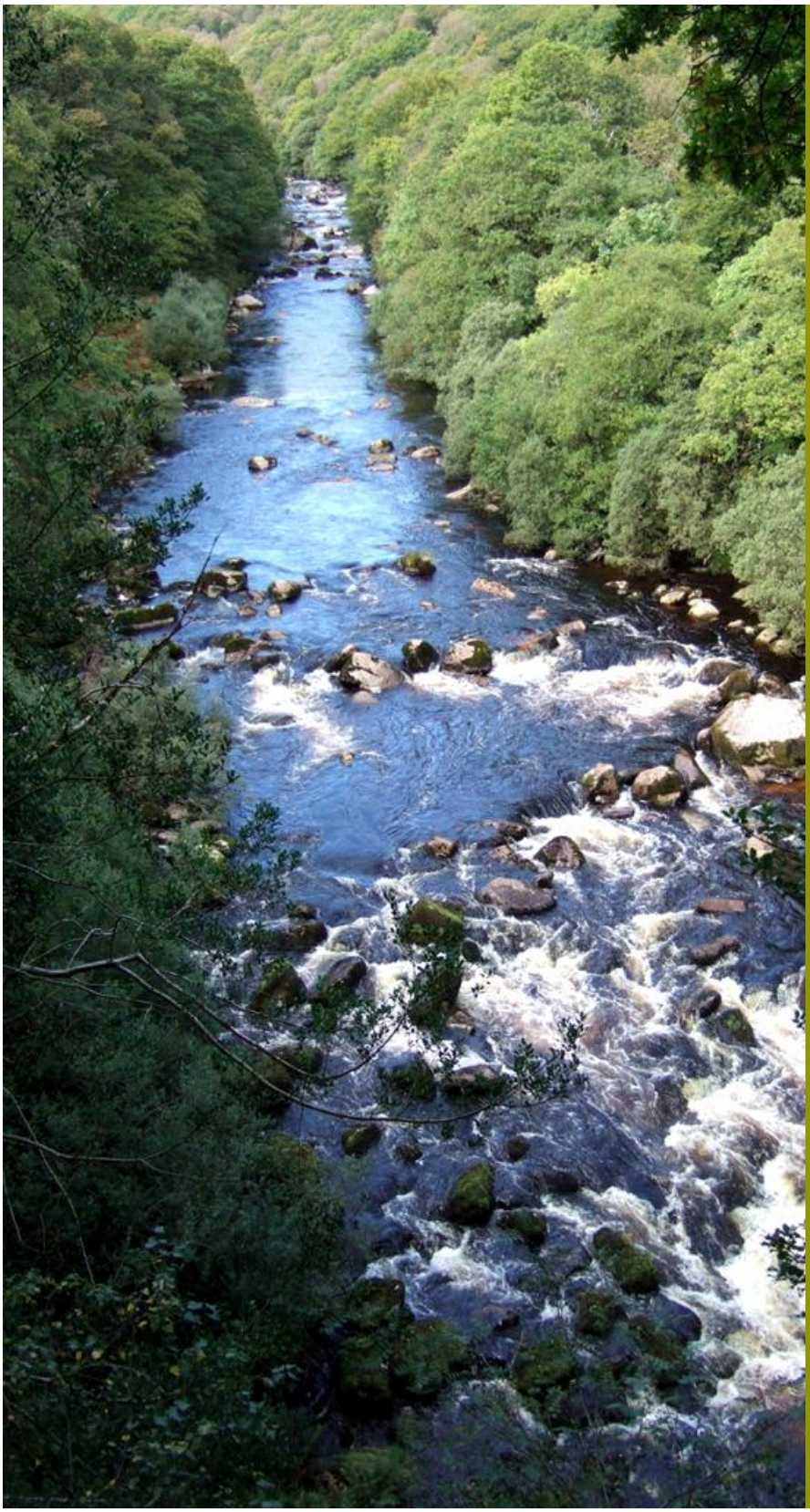
The impact of the UKCP09 modelling outputs has been incorporated into Target Headroom in each WRZ. This has allowed a baseline SDB value to be derived.

From this process, all WRZ's, except for 3, are predicted to be in surplus throughout the 25-year planning period (2010 to 2035). The three WRZ's predicted to be in deficit are North Eyri Ynys Mon, Vowchurch and Pembrokeshire.

Appendix III

PACT Summary Report

Dŵr Cymru Welsh Water



Part 1

PACT Summary Report

Dŵr Cymru Welsh Water

Climate Change Adaptation

Self Assessment June 2010

Produced by Alexander Ballard Ltd on behalf of the UK 2012 Climate

UK 2012 Climate Change Risk Assessment

defra
Department for Environment Food and Rural Affairs

Developing the capacity to adapt to climate change

This report has been prepared in order to contribute to a review of the status of 'adaptive capacity' in the UK water sector, which itself forms part of the UK 2012 Climate Change Risk Assessment (CCRA). The CCRA is being prepared as a requirement of the Climate Change Act 2008 and is the first national risk assessment to be conducted on climate change for the UK.

Future risk assessments are to be carried out on a five yearly basis as a requirement of the Act and this work therefore lays an important foundation for later studies. The project has been undertaken for the Defra (Department for Environment, Food and Rural Affairs) by a consortium led by HR Wallingford Ltd and including ourselves.

The analysis of adaptive capacity in the water sector is being conducted as part of a trial of methods to be used in the CCRA. The water sector is a particularly suitable place to review this topic for a number of reasons:

- There are important climate-related risks in the water sector that require adaptation action
- The sector has previously been identified as having relatively high levels of capacity for taking such adaptation action, which means that ...
- There may be useful lessons to draw from the water sector that can assist other sectors of the economy, which may be less advanced in their capacity.

The definition of adaptive capacity that we are using in the CCRA builds on that of the UK Climate Impacts Programme (UKCIP). It is as follows:

> ***Adaptive capacity – The ability of a system to design or implement effective adaptation strategies to adjust to information about potential climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.***

This is widely agreed to be a very important but also a very challenging subject. Climate change is inherently uncertain and yet many decisions taken now, particularly major capital and infrastructure schemes, need to take those potential changes into account in order to avoid 'maladaptation'. The cost of maladaptation can be very high as poorly taken decisions affecting long term projects and assets are difficult to reverse. This is a particular concern in the Water Sector where many decisions last for decades, or even for centuries.

The management challenge for decision makers is therefore very demanding. Addressing this challenge often requires moving on from a 'business as usual' mindset and may involve a wide range of participants at different levels of the sector.

The methodology that has been chosen for the review of adaptive capacity is PACT. The PACT approach was developed by Alexander Ballard Ltd (ABL) with the assistance of a number of partner organisations that included Hampshire County Council, Climate South East, the Environment Agency, VROM (the Netherlands Ministry of Spatial Planning and the Environment), Kent County Council and other partners during the EU-funded ESPACE Project (European Spatial Planning: Adapting to Climate Events).

Since the end of ESPACE, there has been considerable further development of the approach, which has proven successful in assessing the level of capacity of a wide range of organisations in the public and private sectors, both in the UK and internationally. In particular, the web-based self-assessment approach has been developed by ABL and has been the method adopted for this review.

There is more to follow on the PACT approach in this Summary Report and a fuller description can be found in Appendix 2.

What will happen to the data on adaptive capacity gathered during this exercise?

Through this exercise, we have gathered a substantial amount of information on the status of adaptive capacity in the UK water sector. Alongside other work we are undertaking, which includes interviews with industry organisations and decision makers, this information will be analysed to draw conclusions about the level of adaptive capacity in the water sector and about how capacity in the water sector compares with that in a selection of other sectors.

This study will be used to draw general conclusions about:

a) where priorities lie for increasing adaptive capacity in the UK
b) what specific changes might be needed to increase it, and
c) where, if anywhere, policy interventions might be appropriate to assist those changes.

An integral Adaptation Economic Analysis (AEA) will assess the economic benefit of making such changes and the likely cost of doing so.

Organisation-level information will not be shared in such a way as to allow Dŵr Cymru Welsh Water to be identified unless you specifically agree to sharing a case example.

The outputs from the CCRA will be made public in due course with the final CCRA report due in to be laid in parliament in January 2012.

What is the purpose of this report, what is its status, and what does it contain?

This PACT report is being sent to you with our compliments for taking the time to participate in this study. It is designed to give you insights as to where your own adaptation programme is strong relative to what is required and also as to where any improvement efforts might best be focused to assist cost-effective progress.

While it is not intended to fulfil any statutory reporting duties that some organisations face under the Climate Change Act, 2008, we hope that this report might be of assistance in completing some sections of such reports.

We hope that you will find this report useful.

How organisations get better at dealing with climate change

Responses to climate change improve in predictable stages. PACT identifies six levels of response, each of which represents an increase in complexity and also the capacity of an organisation to deal with climate change.

Organisations become active at different response levels as they develop their understanding of climate change and of how to respond to it. Each higher level of response is built on the foundation of the level below.

The six levels of response:

Most organisations of any size would be assessed by PACT as active at the first and second levels of response: **"core business focused"** and **"stakeholder responsive"**. However, many need to be working at the third level of response: **"efficient management."** This is when climate change becomes rooted in core business processes. The disciplined use of approaches such as carbon management systems and adaptation check lists become standard practice at this level.

A 4th level of response: **"breakthrough projects"** needs activating in order to progress beyond efficient management. This is when Senior managers commission projects to explore issues in depth, look beyond the status quo, seek performance breakthroughs and look for insights relevant to the organisation's strategy.

Hopefully, the journey will not stop there. Achieving RL4 should be a staging post towards Response Level 5 **"strategic resilience"** where mainstream focus is on continually building the resilience of organisations and communities both to climate impacts and to a future in which energy could become seriously constrained.

Defining how organisations perform at the highest level, Response Level 6: **"champion organisation"**, is still work in progress since few organisations have managed to consistently operate at this level.

To sustain movement from one level to another requires parallel progress along nine developmental pathways. These are summarised in a brief overview to assist you in interpreting the results of your self-assessment.

Dŵr Cymru Welsh Water's PACT self-assessment review identifies where you currently sit on this journey and where your longer term potential could be.

A more detailed explanation of the framework, its history and evidence base is available in the Appendices.

The nine developmental pathways

PACT is sometimes described as an organisational development tool because it gathers and organises information about nine organisational capacities or pathways necessary for improved performance. These are:

a) **Awareness.** The grasp of what climate change means for society, for the organisation and its mission, and for particular areas of responsibility, now and into the future.

b) **Agency.** The capacity to spot, prioritise and develop opportunities for meaningful and timely action on climate change.

c) **Leadership.** The extent to which a formal leadership team has developed a strategic vision and engages with, supports and legitimises its implementation.

d) **Agents of Change.** How an "ecosystem" or group of champions is identified, developed, empowered and supported so that they can be effective agents of change.

e) **Working together.** The capacity to participate in, learn from, and act in collaborative partnerships with internal and external groups.

f) **Learning.** The extent to which the organisation generates and responds to feedback from innovation, even on a small scale, and makes sense of and communicates new information to improve procedures, strategies and mission.

g) **Managing Operations.** The embedding of procedures to get to grips with climate change in a systematic way to ensure that intentions and policies turn into action.

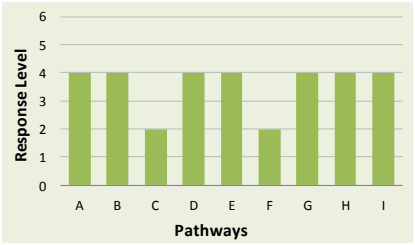
h) **Programme scope and coherence.** How far projects sit within a strategic programme of action suited to the scope of what the organisation is trying to achieve.

i) **Expertise and Evidence.** Ability to identify, access and deploy the necessary technical and change "know-how" and information to make the biggest difference.

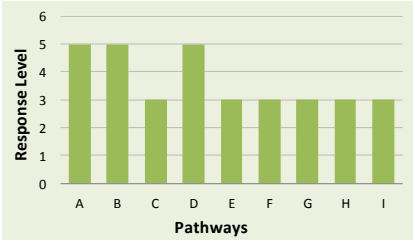
If performance in any one pathway lags behind, it is likely to impair the overall response to climate change. Because the pathways are 'complementary', progress needs to be made along each one at the same rate. So it becomes necessary to understand where each 'pathway' stands relative to others – the purpose of this review.

We usually see one of three generic patterns of response, each with its own challenge:

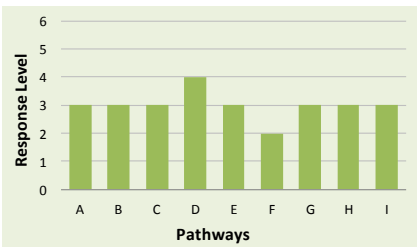
Pattern A: Some lagging pathways. In this pattern, one or two pathways are lagging behind most others. They are likely to be acting as a brake on progress. The payoffs from improving them are likely to be very high – probably higher than trying harder in leading pathways.



Pattern B: Some pathways forge ahead. In this pattern, progress along some pathways is beginning to accelerate. Nobody wants to slow down or stop momentum – and yet there is a great risk that initiatives will fail unless similar progress is made on other pathways. The task is to protect and use leading pathways, as a basis for developing the others.



Pattern C: A stable system. In this pattern, different pathways reinforce each other, making change difficult: whatever happens, it tends to look like more of the same. The task is to unfreeze, change and consolidate. This can happen if you find an opportunity such as a project or working with a single department which allows you to move forward on all pathways at the same time.



How to use this PACT review

Whether you're an organisation at the beginning of the climate change journey or further along the road, a PACT review provides the necessary analysis to assist managers in developing a plan of action. This action plan can be used to identify areas where the organisation needs specialist support and to help them develop a specification to meet those needs, whether by hiring very specific consultancy skills, improving staff training and operations or by joining a climate change improvement network.

PACT can also be used for a strategic review of progress, identifying where activities are forging ahead and where they might be lagging. This allows the cost effective targeting of resources to refresh a current programme or promote a new course of action.

In both cases, PACT systematically helps managers establish a baseline for measuring future progress, which also helps the top team fulfil their governance responsibilities. Moreover, PACT reviews help managers at all levels to prepare for future changes by signalling what is likely to come next after the current cycle of activity has been completed.

Despite recent public spending restrictions in the UK, the need for organisations to develop effective programmes to address climate change has not diminished. This need must clearly be met with an affordable price tag, however, or we risk work being put off until economic conditions improve, which could have a seriously detrimental effect in the face of climate change which will march on regardless of the budget deficit.

As PACT has been designed as an expert service, it provides support in developing plans for adaption and mitigation at around 10% of the cost of a standard consultancy approach. Just as important, this process only requires around 2-3 hours of staff time rather than the many days normally needed to interact with consultants. This allows organisations to focus on improving performance and building resilience without running into resource constraints.

PACT reviews can be used as follows:

- To develop or refocus programmes of activity for both Mitigation and Adaptation
- To identify need for specialist assistance - e.g. on a 'lagging pathway'
- For internal or external 'benchmarking' (as a 'library' of reviews by sector develops)
- To develop specifications for consultancy, training or other specialist support
- For governance purposes by boards of directors, or in due diligence on projects (e.g. acquisitions and mergers)
- To focus on internal auditing (for which we will shortly provide a bespoke service)
- To support external reporting (e.g. one world-leading organisation has just used PACT to support its reporting under the UK's Climate Change Act, 2008)

Disclaimer: As this self-assessment review process has not been moderated for its accuracy, we obviously cannot claim to be 100% sure that our judgements of your organisation are completely accurate. Our conclusions are based solely upon your answers in the questionnaire, and not upon any other former knowledge of your organisation. The self-assessment process has not been intended to be an audit, and we do not in any way intend to imply we have moderated the validity of your answers. We assume that your answers have been given in good faith and that they have been answered to the best of your knowledge. We therefore recommend that anybody taking decisions based on the findings of this report take steps to verify information prior to commencing any activity that is dependent upon its content.

Please also note that a considerable number of your responses were in the form of comments. We believe that we have understood the perspective from which you were writing and have done our best to interpret these appropriately. In the event of any mistakes (most likely to show up in Volume 2 as an activity shown at an incorrect status) please do identify them, send them to us and we can, if necessary, revise the report, benefitting both the CCRA and, hopefully, yourselves.

At what response level does Dŵr Cymru Welsh Water need to operate?

From the answers you have given in your PACT Self-Assessment questions we can deduce that it is very likely that your organisation needs to be able to operate at Response Level 5 "Strategic Resilience". The main reasons for this are that:

- You have indicated that your organisation has ambitions to exist more or less indefinately into the future; a future that is expected to bring significantly different weather patterns.
- You are currently responsible for fixed assets that you intend to manage for decades into that future.
- Your organisation has a policy commitment, or a statutory obligation, to promote sustainable development.
- You indicated that your organisation frequently influences decisions that may be expected to have consequences for decades into the future (these are often costly to reverse).

Operating consistently at this target level requires some rare and rather sophisticated capabilities that very few organisations currently have or even know they need. Working from lower level responses to get to this level may realistically take years to achieve. However, developing the capabilities to progress up the response levels can be an exciting and fulfilling experience for those involved. It requires considerable determination and motivation to achieve, but without developing these skills your organisation will remain vulnerable.

We are pleased to see, that unlike many, Dŵr Cymru Welsh Water are already showing encouraging signs that they understand what Response Level 5 work looks like a few areas.

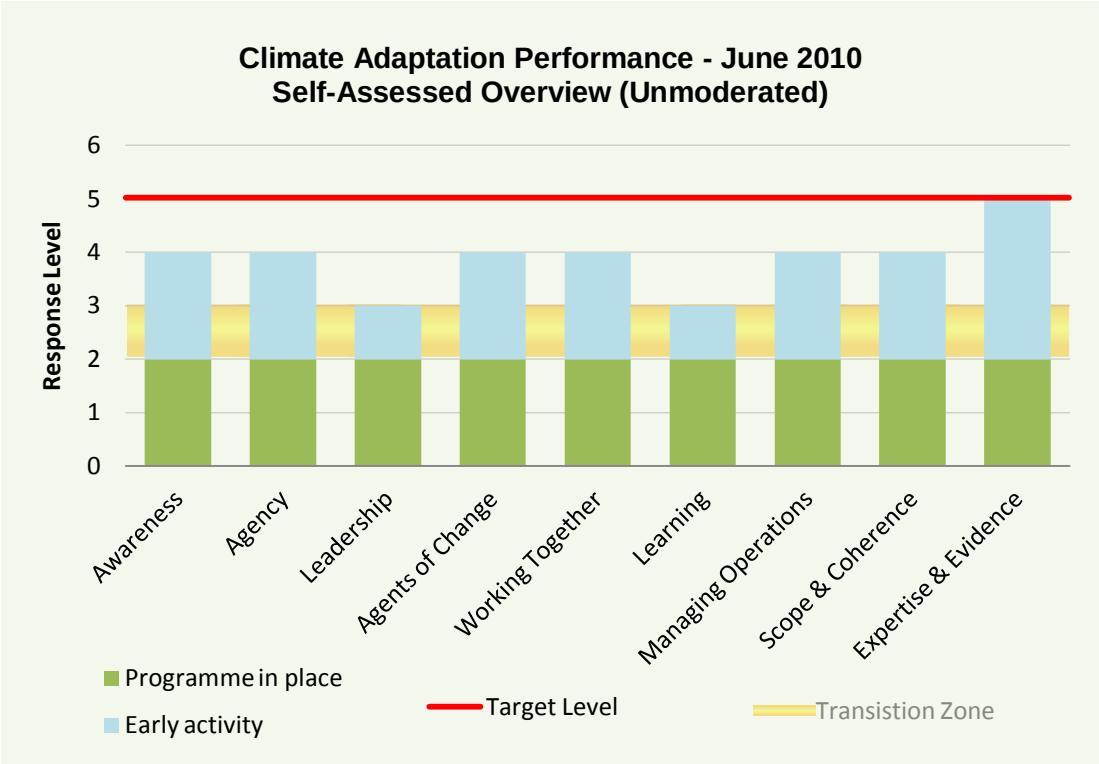
Society and organisations need to prepare for a radically different and uncertain future. There needs to be an appreciation that addressing climate adaptation means embarking upon a journey of discovery, and we are pleased to see that your organisation seems to acknowledge this.

Often organisations that have low awareness of what future climate impacts will mean to their organisation are unaware of their progress, and can sometimes think they have cracked it. You indicated that you felt your organisation was at the early stages of developing a programme on climate adaptation, and your answers imply this is the case. This is good to see as recognition of where you're at on this journey is an important aspect of being able to improve performance.

Some organisations leading on climate adaptation are beginning to be respected for some very innovative and worthwhile work. With some guided effort from the findings of this review, we hope that Dŵr Cymru Welsh Water could become one of them.

Your target response level is shown as a red line on your PACT Overview Graph overleaf.

So what is the picture in Dŵr Cymru Welsh Water?



Legend: The green areas represent where Dŵr Cymru Welsh Water's current response level on adapting to climate change is solid. Any lighter blue areas represent where there are indications of early activity. While the areas of early activity are not yet solid at the higher level, these represent signs of where the organisation is beginning to move ahead.

The area shown as the Transistion Zone highlights where the overall system is poised to move to a higher level of response and can be seen as an interim goal as the organsation approaches its target level marked in red.

Your transition zone: PACT RL2 to RL3. Dŵr Cymru Welsh Water is engaged in the challenge of the transition from RL2 to RL3. Successfully achieving this will be an important step, providing a strong foundation from which it will be possible to move forward quickly towards your longer term goals. At RL3, an organisation brings the adaptation agenda into its mainstream operational systems, providing it with similar structures and resources that are provided to other legitimate areas of management activity.

For example, organisational leaders begin to set intermediate goals to improve performance – often 'process goals' to improve systems of management. Operational systems such as ISO 14001 or ISO 9001 or equivalent are used to ensure that procedures are amended to take account of these goals, that people get the training they need, that learning from activities is used to improve processes, that appropriate expertise is used.

A formal improvement plan is agreed and adequately resourced with professional staff and external experts. Policy begins to be built upon solid foundations of evidence and managers begin to expect that a 'business case' can be put together for changes based on this evidence. The issue begins to be addressed in the organisation's engagement with stakeholders.

Moderator's comment: Although we do not normally do so, we occasionally comment on particularly interesting responses or on a PACT transition that raises interesting challenges.

Many of your responses to the PACT questionnaire showed that you also see the current challenge for Dŵr Cymru as being that of embedding adaptation within the mainstream of your organisation. This PACT review strongly supports this perspective – at the current stage in your adaptation programme. In due course, however, once you have succeeded in embedding adaptation responses in the mainstream, it is very possible that you will benefit from exploring the areas in which adaptation responses cannot be achieved without bigger changes. This will in time (perhaps 12 months or more away) become the exciting PACT response level 3 to 4 transition. You can read more about this, whenever convenient, within Appendix 2 attached.

Your reponse pattern: c If we look at your pattern for Adaptation the pattern is C - a stable system, with considerable early activity ahead of the status quo. The stable system is a very common pattern. It is both good news and bad news. The good news is that it is very likely that the level that you have reached is well established and works reasonably well 'as a system'. The less good news is that it can be harder to shift such a system, because if you change only one pathway the performance will be pulled back by the other pathways.

It is imperative that you forge ahead across the various pathways in parallel, thereby setting up a coherent system at the new level. The standard approach to doing this is 'Unfreeze, change, consolidate'.

Where we suggest you focus efforts: In Part 2 – PACT Pathways Analysis – you will find a list of activities that you would expect to see implemented at the next response level.

In closing

We would also like to take this opportunity to thank you for being one of the organisations that have been involved in this review of adaptive capacity in the UK water sector that has been carried out as part of the UK 2012 Climate Change Risk Assessment.

We wish you every success with your organisation's future work on climate adaptation. While this work is challenging in several respects, we think that it is also exciting work that calls us to ask ourselves what matters to us and to the people whom we serve, whether our families, our fellow citizens, our service users, customers, shareholders, whoever. As we become clear about what matters, then we can develop the clarity of purpose that we need to help our society become increasingly resilient to a changing future.

We think that this is work worthy of human endeavour, and hope very much that this PACT review has been, and that PACT might perhaps in future also be, helpful to you as you continue along this journey.

Appendices

There are three appendices:

1. The text of your answers to the questionnaire
2. A substantial overview of the PACT methodology
3. A summary of services provided by ourselves to build capacity

These are attached to the email we sent with this report.

Appendix IV

Brief description of existing 'process based' adaptation measures

STRATEGIC DIRECTION STATEMENT

Our Sustainable Future (SDS) sets out our strategic objectives for the next 25 years. Specific key targets for the business to achieve in response to the potential impacts of climate change are identified. This demonstrates our commitment to take into account and prepare our business for the climate change impacts. For details see www.dwrcymru.com

As is clearly shown in this report, the SDS has been and will be the key instrument we refer to in operating our functions and delivering our services.

SUSTAINABILITY POLICY

This is a high level policy, which commits Welsh Water to ensuring sustainability issues are effectively encompassed in all our operational and management decision making in a way that promotes the sustainability of our business, the resources we use and the environment we operate in.

It is in place to ensure that sustainability is fundamental and included in all aspects of our functions. This is in line with the Welsh Assembly Government's aspiration and duty for sustainable Wales.

CARBON REDUCTION ROUTE MAP AND CARBON REDUCTION COMMITMENT

The route map will enable Welsh Water to meet the targets set in its 25 year SDS, which is to achieve a reduction in our carbon footprint of 25% by 2015 and 50% by 2035.

As a mitigation measure, the route map provides an organisational framework and conditions in which carbon projects can be identified, prioritised, planned and implemented systematically and consistently across all operations.

While driving Welsh Water to reduce its emission, the route map will also be instrumental in our adaptation process as it identifies practical steps to ensure that climate change (and carbon emission) is taken into account in all operational functions and decision making processes within the company.

ENERGY POLICY

Our operation, particularly water and wastewater treatment, tends to be energy intensive. As a result, our energy consumption is large and we are one of the top ten energy consumers in Wales. We recognise that efforts need to be made to minimise our energy usage. With this policy in place, we will develop and adopt innovative techniques in both design and operation of our processes as well as taking advantages of opportunity for renewable energy generation.

The policy committed Welsh Water to effective monitoring, managing and limiting our energy use, through efficiency in our operational processes and design. This is a high level policy, which drives a number of strategies including renewable energy

The policy will also help drive the business to meet the carbon reduction target set in our SDS.

WATER RESOURCE MANAGEMENT PLAN

An assessment of the impact of climate change on Deployable Output and consequently on the Supply Demand Balance in each Water Resources Zone has previously been undertaken for the purpose of the company's draft Water Resources Management Plan (2009), using the UKWIR06 and UKWIR07 climate change scenarios [11].

UKCP09 published in June 2009 provides us with an opportunity to reassess the potential impact of climate change which also supports the company's commitment to improving its understanding of this issue as identified in our final business plan and our SDS.

[11] Based on the climate projections published by the UK Climate Impact Programme 2002 (UKCIP02), UKWIR (2006 and 2007) developed more localised and catchment specific climate change factors. There are significant variations between the UKCIP02 and the UKWIR07 forecasts, which also provide significantly improved results.

Welsh Water has been the first water company in the UK to assess the implications of UKCP09 on its water resources activities. We believe the work we have undertaken is robust, comprehensive and pioneering and is leading the way for other water companies to follow.

Currently there is no industry guidance on how the UKCP09 results should be applied in water resources planning but we have decided to progress an early assessment to provide the business and our regulators with an indication of the scale of the potential changes and the implications for the final Water Resource Management Plan. It is likely that this work will help inform research and updates to WRMP guidance.

Linking to the WRMP is a drought plan which outlines our communication and operational strategy that will be deployed under drought conditions. We produced a Draft Drought Plan in 2006 and we are currently awaiting direction from the Welsh Assembly Government prior to publishing the final plan.

WATER EFFICIENCY STRATEGY

In its statutory environmental and social guidance to Ofwat (2008), Welsh Assembly Government fully recognises the environmental benefits that result from more efficient and sustainable use of water. It sees that reduced demand of water leads to reduced wastewater, which in turn results in reduced infrastructure requirements and energy costs and increased resilience to climate change.

Corresponding with Welsh Assembly Government's view, water efficiency is a key strategy supporting our WRMP. It is also a core theme in our education programme through schools and in the community we serve.

We promote water efficiency through our 'Be Waterwise' campaign. The campaign encourages customers to use water wisely and avoid waste - in the interests of both the environment and customers.

Our core message is "use as much drinking water as you need, but please don't waste it", and that small measures to save water can, when aggregated, help manage the effects of climate change and contain any increase in overall water consumption.

SURFACE WATER MANAGEMENT STRATEGY

The strategy has been developed to address the potential problem of overloading the wastewater network and to build resilience for the network. It aims to raise awareness of issues caused by surface water and enable engagement with interested bodies, in order to work together to deliver a solution.

The initial driver for the strategy is the increasing urban 'creep', which resulted in greater surface water run-off. This together with the predicted variable in annual precipitation could impose significant pressure on the existing wastewater network.

As stated in its Strategic Position Statement on Water (2009), Welsh Assembly Government also keen to support further research and development of sustainable urban drainage systems to alleviate the pressure on the wastewater network and help reduce flood risk. For this asset management planning cycle, we have already seen significant contribution from Welsh Assembly Government towards the delivering our pilot schemes in Wales.

The strategy will deliver many benefits, highlights of which are: -

- The reduction of predicted future flooding and pollution incidents;
- Decreasing carbon emissions and energy costs;
- Supporting conservation and recreational opportunities within the community;
- It counters impermeable area 'creep'; and
- It will be instrumental in minimising the impacts of climate change.

We believe this is a proactive initiative that will help us building our adaptive capacity.


Dŵr Cymru
Welsh Water